OPERATING INSTRUCTIONS

PLOC2D 4.1

2D Vision for Robot Guidance

SICK
Sensor Intelligence.

Described product

PLOC2D

Manufacturer

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Legal information

Original document

This document is an original document of SICK AG.

Contents

1 About this document

1.1 Information on the operating instructions

These operating instructions provide important information on how to use devices from SICK AG.

Prerequisites for safe work are:

- Compliance with all safety notes and handling instructions supplied.
- Compliance with local work safety regulations and general safety regulations for device applications

The operating instructions are intended to be used by qualified personnel and electrical specialists.

NOTE
Read these operating instructions carefully to familiarize yourself with the device and its functions before commencing any work.

The instructions constitute an integral part of the product and are to be stored in the immediate vicinity of the device so they remain accessible to staff at all times. Should the device be passed on to a third party, these operating instructions should be handed over with it.

These operating instructions do not provide information on operating the machine or system in which the device is integrated. For information about this, refer to the operating instructions of the specific machine.

1.2 Scope

This document applies to the following products of the PLOC series:

- PLOC2D

1.3 Explanation of symbols

Warnings and important information in this document are labeled with symbols. The warnings are introduced by signal words that indicate the extent of the danger. These warnings must be observed at all times and care must be taken to avoid accidents, personal injury, and material damage.

DANGER
... indicates a situation of imminent danger, which will lead to a fatality or serious injuries if not prevented.

WARNING
... indicates a potentially dangerous situation, which may lead to a fatality or serious injuries if not prevented.

CAUTION
... indicates a potentially dangerous situation, which may lead to minor/slight injuries if not prevented.

NOTICE
... indicates a potentially harmful situation, which may lead to material damage if not prevented.

NOTE
... highlights useful tips and recommendations as well as information for efficient and trouble-free operation.

2 Safety information

2.1 Intended use

PLOC2D is a part locator sensor for robot guidance. PLOC2D is primarily designed for use in industrial and logistics areas, and it meets the requirements for industrial ruggedness, interfaces and data processing. It is not a safety component as per the Machinery Directive 2006/42/EC. It is not intended and not permitted to be used in areas with explosive atmospheres, in corrosive environments, or in extreme ambient conditions.

2.2 Incorrect use

Any use outside of the stated areas, in particular use outside of the technical specifications and the requirements for intended use, will be deemed to be incorrect use.

The RG-system is NOT a safety component according to the respective applicable safety standards for machinery. The position data of the RG-system must NOT be used for safety-critical control of the robot or the system. The RG-system must NOT be used for functional safety.

The RG-system must NOT be used in explosion-hazardous areas, in corrosive environments, or under extreme environmental conditions.

Any use of accessories not specifically approved by SICK AG is at your own risk.

If the RG-system is to be used under other conditions or in different environments, then the manufacturing service may issue an operating license in consultation with the customer and in exceptional cases.

2.3 IP technology

NOTE
SICK uses standard IP technology in its products. The emphasis is placed on availability of products and services. SICK always assumes that the integrity and confidentiality of the data and rights affected by the use of the aforementioned products will be ensured by the customer. In all cases, appropriate security measures, such as network separation, firewalls, virus protection, and patch management, must be taken by the customer on the basis of the situation in question.

2.4 Limitation of liability

Applicable standards and regulations, the latest state of technological development, and our many years of knowledge and experience have all been taken into account when assembling the data and information contained in these operating instructions. The manufacturer accepts no liability for damage caused by:

- Failing to observe the operating instructions
- Incorrect use
- Use by untrained personnel
- Unauthorized conversions
- Technical modifications
- Use of unauthorized spare parts, consumables, and accessories

With special variants, where optional extras have been ordered, or owing to the latest technical changes, the actual scope of delivery may vary from the features and illustrations shown here.

2.5 Modifications and conversions

Modifications and conversions to the product and/or the installation may result in unforeseeable dangers. Before any technical modifications to and expansions of the product, the prior written approval of the manufacturer must be obtained.

2.6 Operational safety and particular hazards

Please observe the safety information and the warnings listed here and in other chapters of these operating instructions to reduce the possibility of risks to health and avoid dangerous situations.

CAUTION
Class 1/1M laser beam!

The accessible beam does not represent a hazard even if you view it directly for a long period of time (base period of 100 seconds).

1. Never look into the laser beam directly with optical instruments (e.g., magnifying glasses, microscopes, telescopes/binoculars)
2. Current national regulations regarding laser protection must be observed.

CAUTION
LED risk group 1

The accessible beam from the illumination unit (RG 1) does not represent a risk due to the normal restrictions imposed by human behavior.

LED risk group 2

The accessible beam from the illumination unit (RG 2) does not represent a risk due to aversion responses to very bright light sources and the perception of heat.

For both types of beams

It is not possible to entirely rule out temporary, disorienting optical effects on the human eye (e.g., dazzle, flash blindness, afterimages, impairment of color vision, photosensitive epilepsy at flash frequencies of between 1 Hz and 160 Hz, depending on the configuration), particularly in conditions of dim lighting. No safety precautions are required.

Comply with the latest version of the applicable regulations on photobiological safety of lamps and lamp systems as well as on laser protection.

If the product is operated in conjunction with external illumination systems, the risks described here may be exceeded. This must be taken into consideration by users on a case-by-case basis.

CAUTION
Dangerous exposure to radiation

If any operating or adjusting devices other than those specified here are used or other methods are employed, this can lead to dangerous exposure to radiation. Damage to the eyes is possible.

- If the product is operated in conjunction with external illumination systems, the risks described here may be exceeded. This must be taken into consideration by users on a case-by-case basis.
- Do not look into the light source when it is switched on.
- Comply with the latest version of the applicable regulations on photobiological safety of lamps and lamp systems as well as on laser protection.

For internal illumination, only units provided by SICK for that purpose may be used.

2.7 Qualification requirements for personnel

WARNING
Risk of injury due to insufficient training.
Improper handling may result in considerable personal injury and material damage.

- All work must only ever be carried out by the stipulated persons.

These operating instructions list the training requirements for the various fields of activity, as follows:

- **Instructed personnel** have been given a briefing by the operator about the tasks assigned to them and about potential dangers arising from improper action.
- **Skilled personnel** have the specialist training, skills, and experience, as well as knowledge of the relevant regulations, to be able to perform tasks delegated to them and to detect any potential dangers independently.
- **Electricians** have the specialist training, skills, and experience, as well as knowledge of the relevant standards and provisions to be able to carry out work on electrical systems and to detect any potential dangers independently. Relevant applicable national regulations must be observed.

3 Product description

3.1 System overview

PLOC2D is a robot guidance system, utilizing a part locator sensor, InspectorP6xx, together with the PLOC2D software. PLOC2D also supports user-created plugins, see seperate documentation on **SICK Support Portal**.

PLOC2D is configured with a PC via a web-based graphical user interface.

3.2 Scope of delivery

Depending on the device version and the accessories ordered, the scope of delivery will include the listed items:

- PLOC2D sensor
- Two sliding nuts, M5
- Light inlet and electrical connections fitted with protective caps/plugs.
- SW 2 hexagon key for opening and closing the cover of the micro SD card slot.
- SICK lens cloth

Accessories

Accessories, such as brackets and connecting cables, are only supplied if ordered separately

3.3 Product ID

3.3.1 Type label

The type label gives information for identification of the sensor.

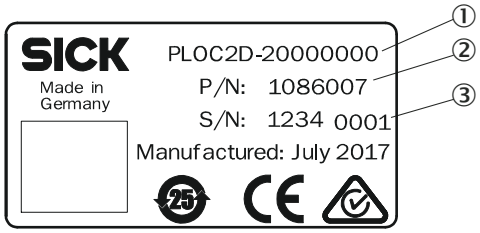


Figure 1: Type label design for the sensor

① Type code

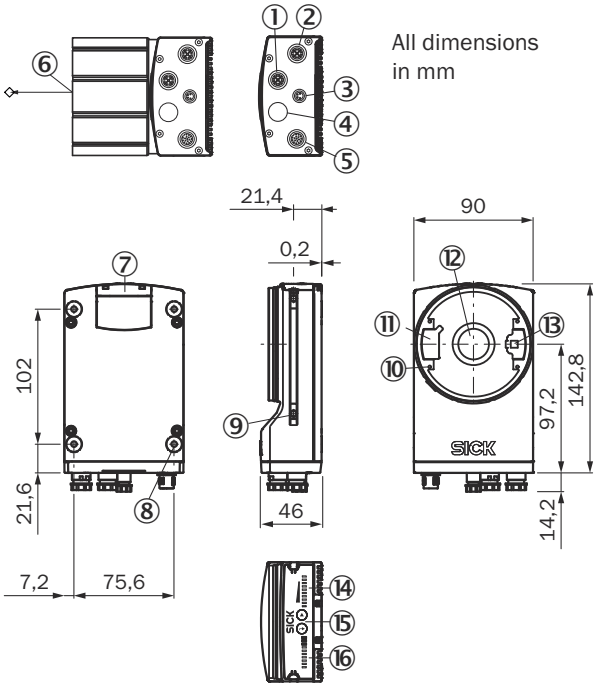
② Product identification number

③ Serial number

3.4 Product characteristics

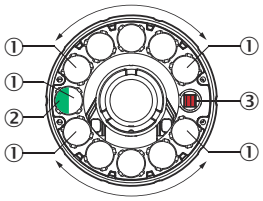
3.4.1 Device view (InspectorP65x)

Dimensional drawing of InspectorP65x devices



① Connection P1, not used
② Connection P3, Gigabit Ethernet
③ Connection X2, not used
④ Connection P2, not used
⑤ Connection X1, Power and I/O
⑥ Reference point for working distance (center of front screen) from PLOC2D to object
⑦ Black cover for the micro SD memory card slot
⑧ M5 blind tapped holes, 5 mm deep (4 x), for mounting the PLOC2D
⑨ Sliding nut M5, 5.5 mm deep (2 x), pivoting, for an alternative method of mounting the PLOC2D
⑩ M2.5 blind tapped holes, 5.5 mm deep (4 x), for mounting the lighting spacers
⑪ Cover for lighting connector
⑫ Light inlet with C-mount thread
⑬ Outlet opening for light beam from aiming laser
⑭ Bar graph display (10 x LEDs)
⑮ Function button (2 x)
⑯ LEDs for status display (10 x 2 levels)

Integrable illumination unit (fixed)



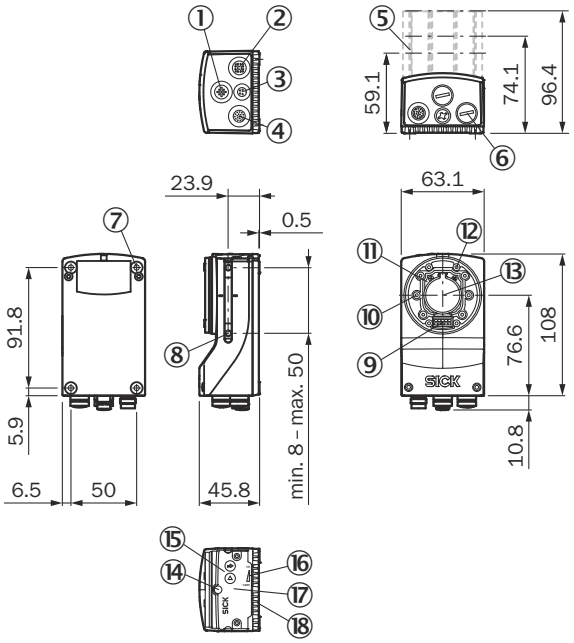
① Illumination via 11 LEDs

② Feedback LED

③ Opening in the illumination for the aiming laser

3.4.2 Device view (InspectorP63x)

Dimensional drawing of InspectorP63x devices



① External illumination connection

② Gigabit Ethernet port

③ USB port, not used

④ Power, serial, CAN, and I/O connection

⑤ 22.7 mm, 37.7 mm, or 60 mm protective optics cover

⑥ Protective caps/plugs to seal any electrical connections that are not in use

⑦ M5 blind tapped holes, 5.5 mm deep (4 x), for mounting the sensor

⑧ M5 sliding nut, 5.5 mm deep (4 x), pivoting, for an alternative method of mounting the sensor

⑨ Internal illumination connection

⑩ Aiming laser (2 x)

⑪ S-mount or C-mount optics module

⑫ 2.5 mm blind tapped holes (4 x) for mounting the spacers for the integrable illumination

⑬ Optical axis and center of the image sensor

⑭ Manual focus screw, underneath cover/label (S-mount)

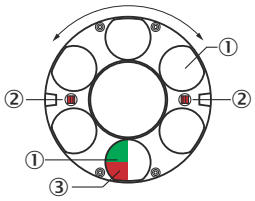
⑮ Function button (2 x)

⑯ LED bar graph (5 x)

⑰ Removable cover for microSD card and manual focus screw (S-mount)

⑱ LEDs for status display (5 x 2 levels)

Integrable illumination unit (option)



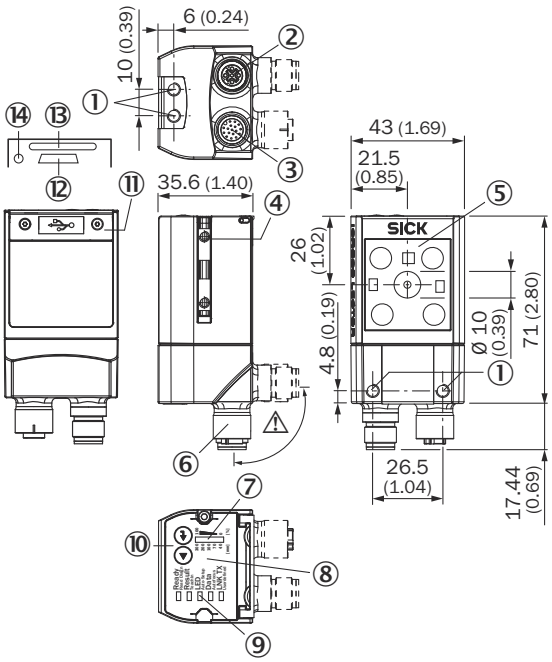
① Illumination via 6 LEDs

② 2 openings in the illumination for the aiming laser for alignment: the red laser LEDs can be switched off and each generates a red dot on the object within the field of view

③ Feedback LED

3.4.3 Device view (InspectorP62x)

Dimensional drawing of InspectorP62x devices



① Blind tapped hole M5, 5 mm deep (4x), for mounting the sensor

② Gigabit Ethernet

③ Power and I/O connector

④ Sliding nut M5, 5.5 mm deep (2x), for an alternative method of mounting the sensor

⑤ Reading window with internal illumination LEDs (4x)

⑥ Swivel connector (swivel range 180°)

⑦ Bar graph display

⑧ Beeper (under the housing)

⑨ Status LEDs (5x LEDs, 2 levels)

⑩ Function buttons (2x)

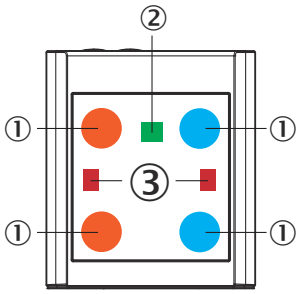
⑪ Cover (flap) with fixing screw, Torx TX6 (2x)

⑫ USB port

⑬ Slot for microSD memory card

⑭ Status display (LED) for microSD memory card

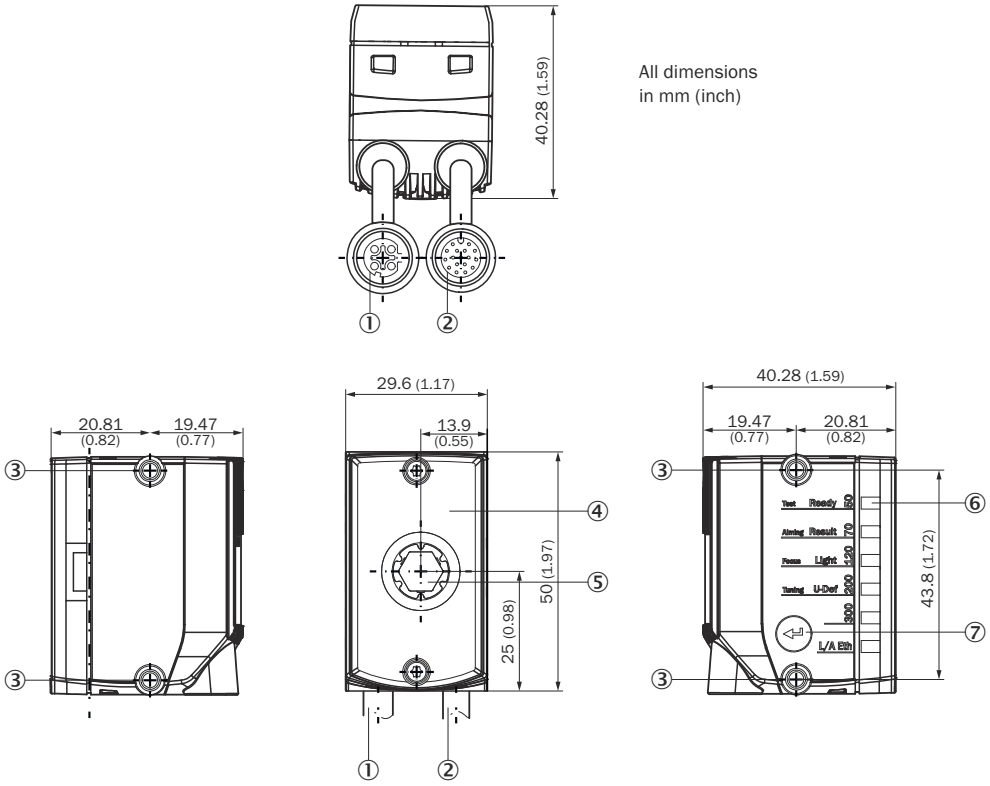
Illumination unit (integrated)



① 4 LEDs (color: visible red light, visible blue light; position: 2 on the left, 2 on the right)
② Feedback LED (color: visible green light)
③ Laser alignment aid (color: visible red light)

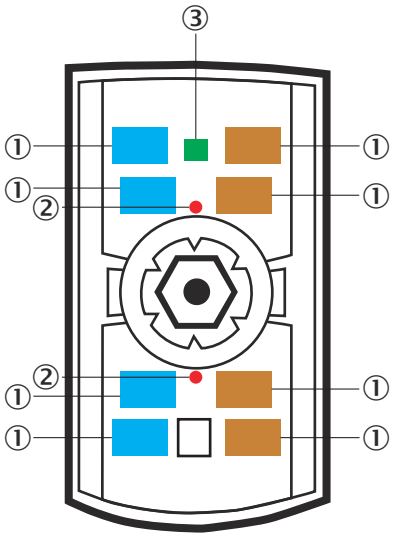
3.4.4 Device view (InspectorP611)

Dimensional drawing of InspectorP611 devices



① Connecting cable with Ethernet connection, length of cable: 0.25 m
② Connecting cable with Power and I/O connection, length of cable: 0.35 m
③ 4 tapped blind holes, M4, 6.4 mm deep for mounting the device
④ Viewing window with 8 integrated illumination LEDs, 2 LED alignment aids, 1 feedback LED, 1 time-of-flight sensor
⑤ Optics, manual focus adjustment with the help of a focus adjustment tool
⑥ 6 status LEDs to display the focus position and working distance, device status, and device function (3 display levels)
⑦ Function button

Illumination unit (integrated)



① 8 integrated illumination LEDs (color: 4 visible amber light, 4 visible blue light)

② 2 LED alignment aids, can be deactivated (color: visible red light)

③ Feedback LED (color: visible green light)

3.4.5 Status indicators and functions

① Return pushbutton

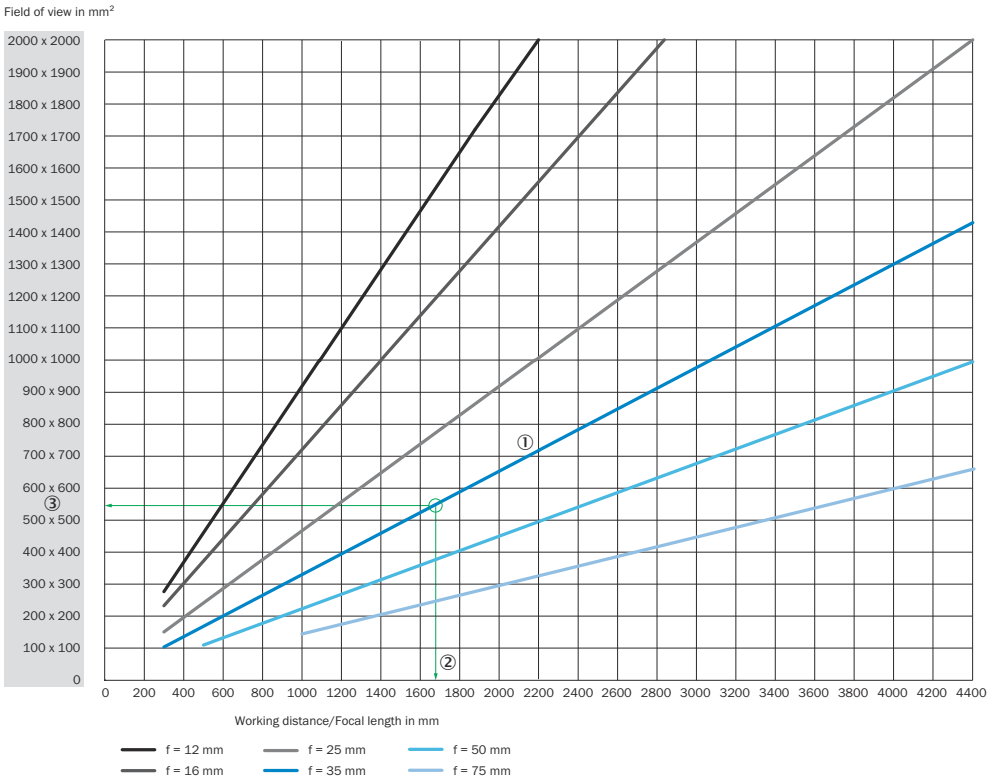
② Arrow pushbutton (not used)

Status indicators are only used to indicate that the PLOC2D system is powered on.

3.4.6 Field of view diagrams

The diagrams show the dimensions of the field of view for a certain working distance and lens focal length.

InspectorP65x



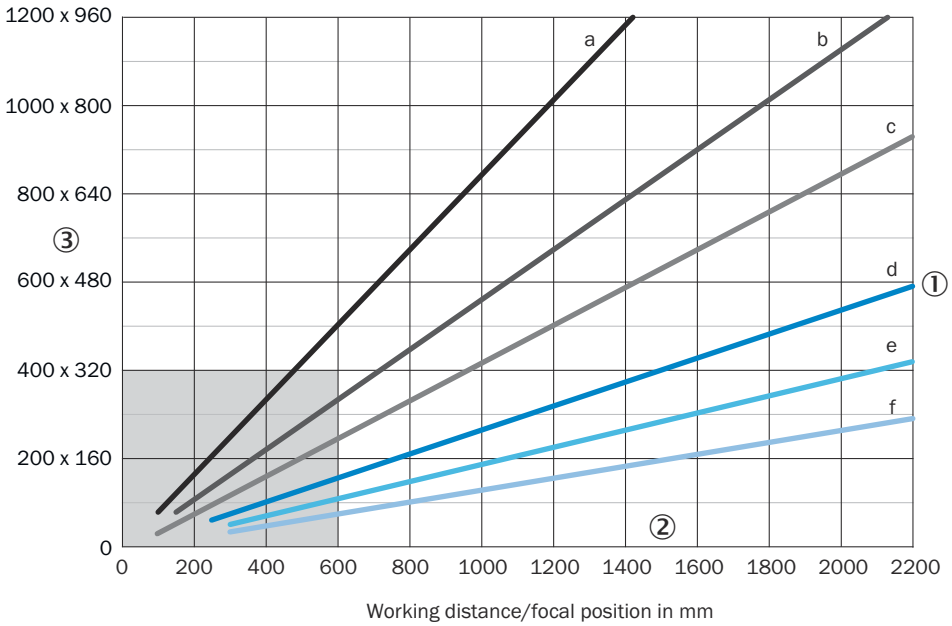
① Lens focal length

② Working distance in mm

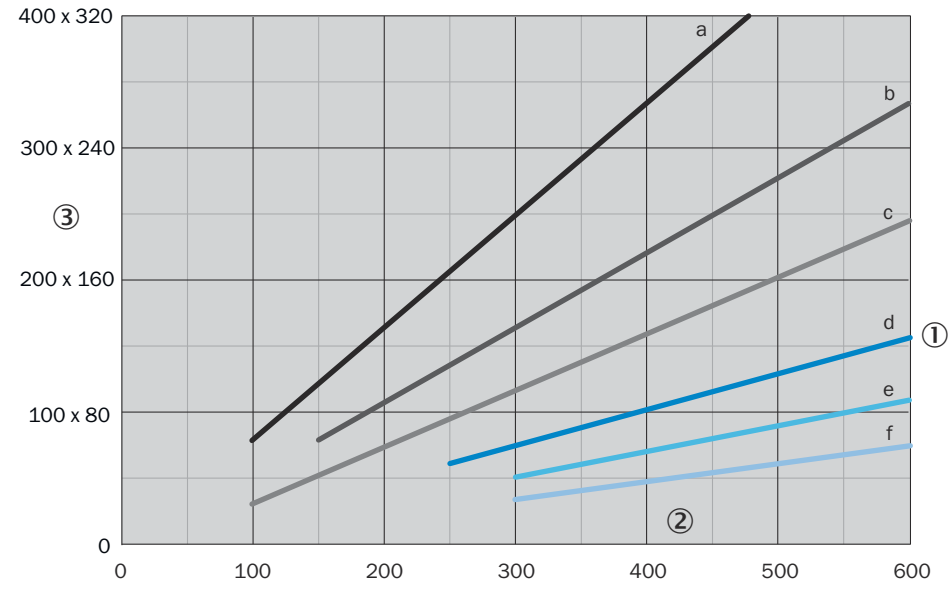
③ Field of view in mm²

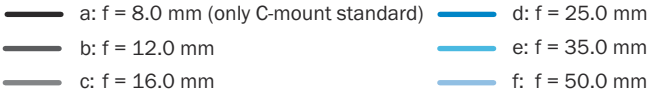
InspectorP631 C-mount

Field of view in mm²



Field of view in mm²

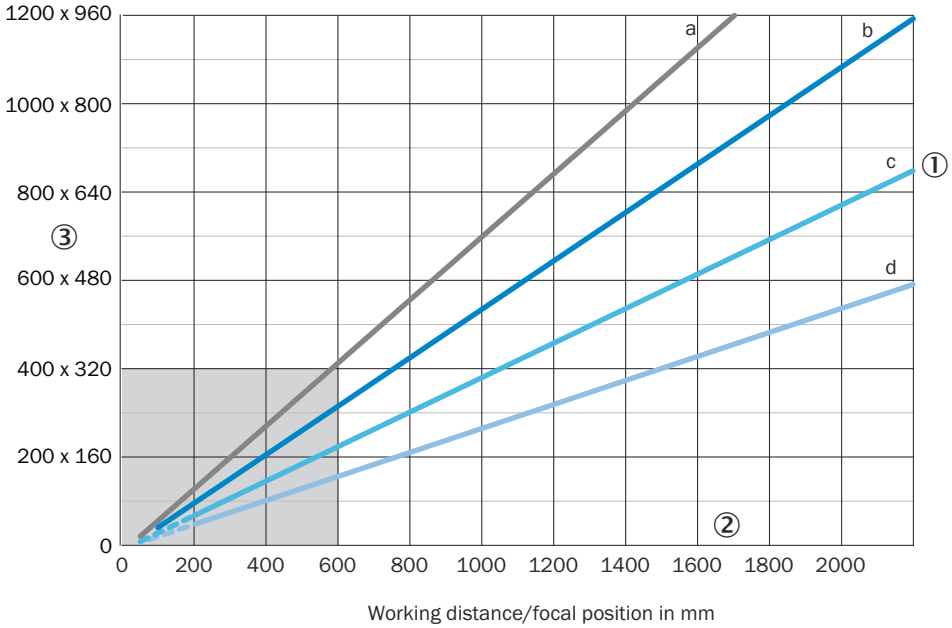




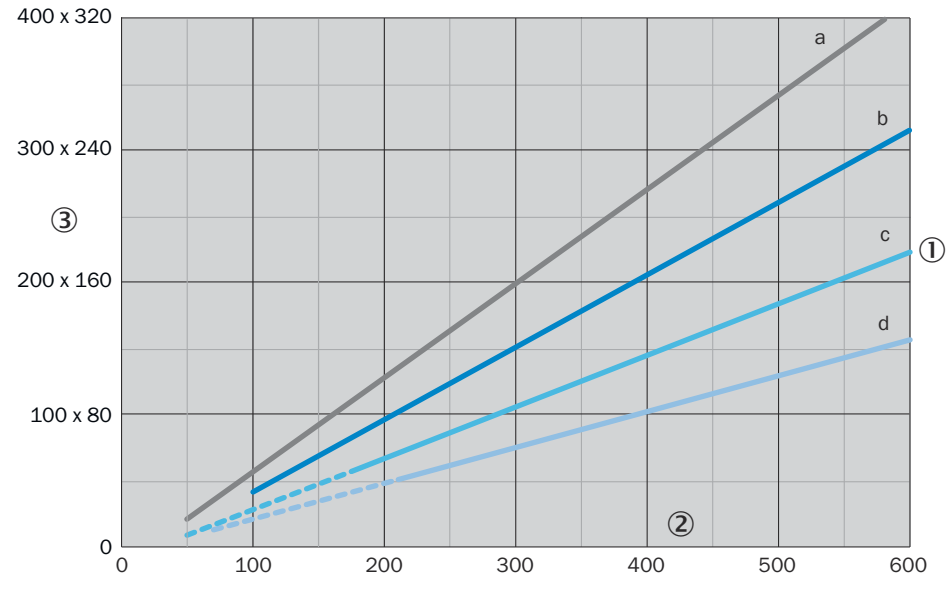
① Lens focal length
② Working distance in mm
③ Field of view in mm²

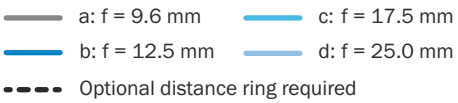
InspectorP631 S-mount

Field of view in mm²



Field of view in mm²

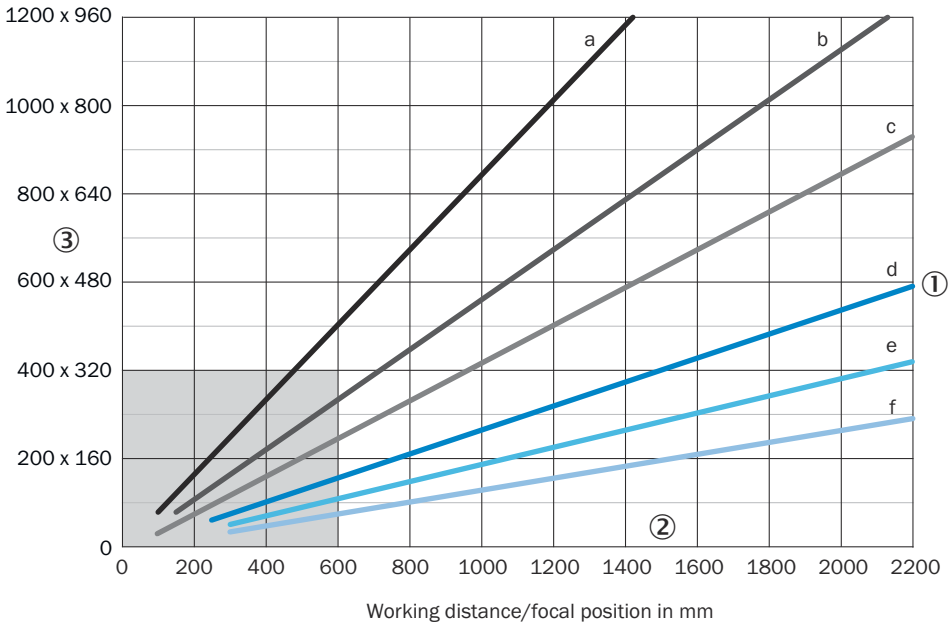




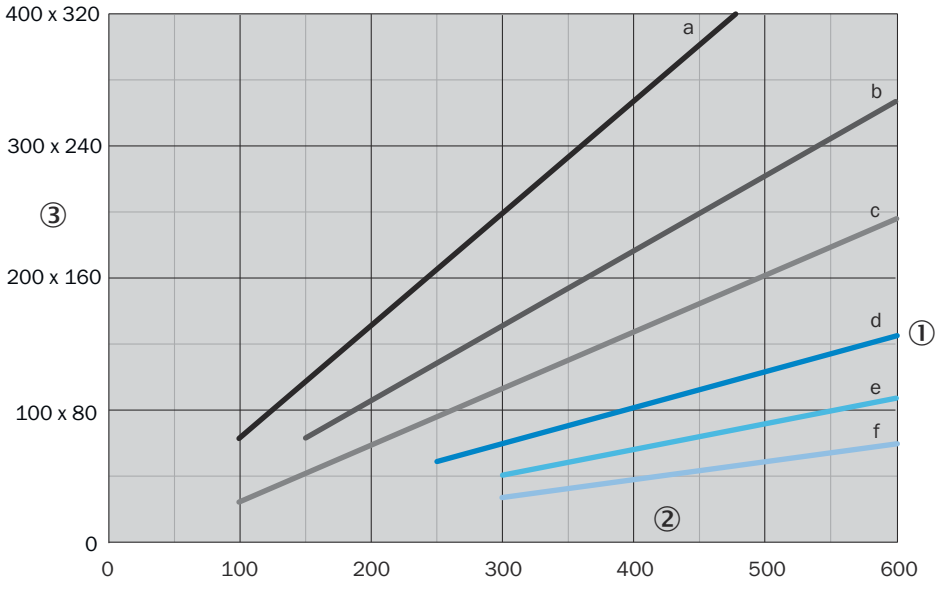
① Lens focal length
② Working distance in mm
③ Field of view in mm²

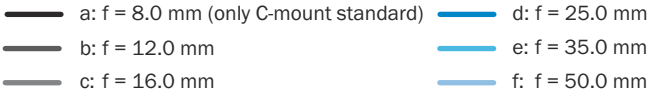
InspectorP632 C-mount

Field of view in mm²



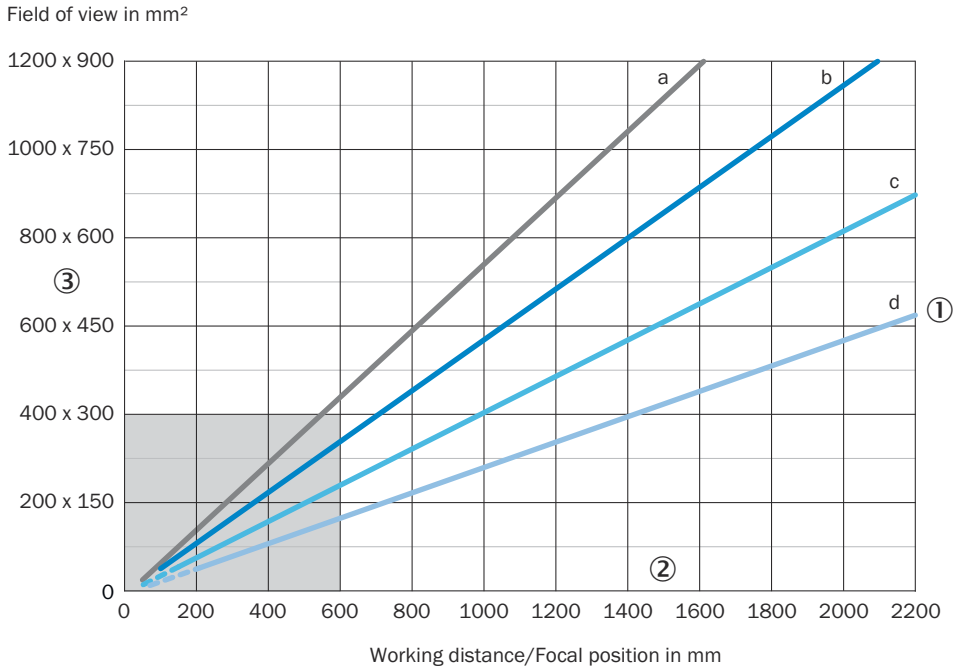
Field of view in mm²

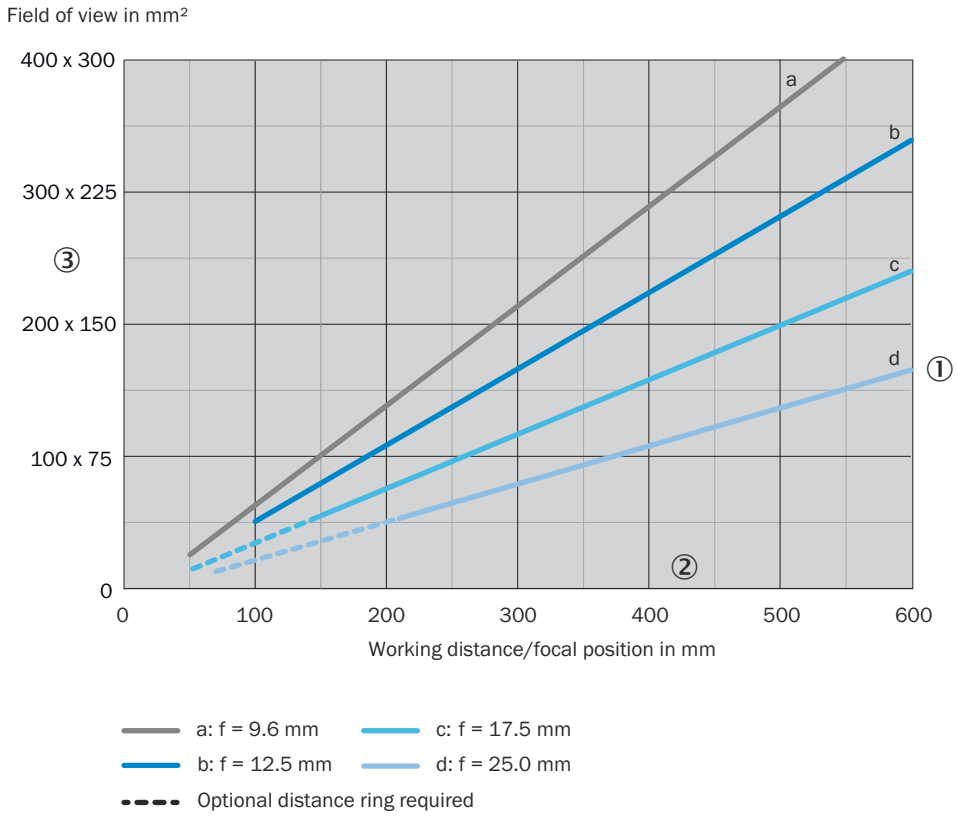




① Lens focal length
② Working distance in mm
③ Field of view in mm²

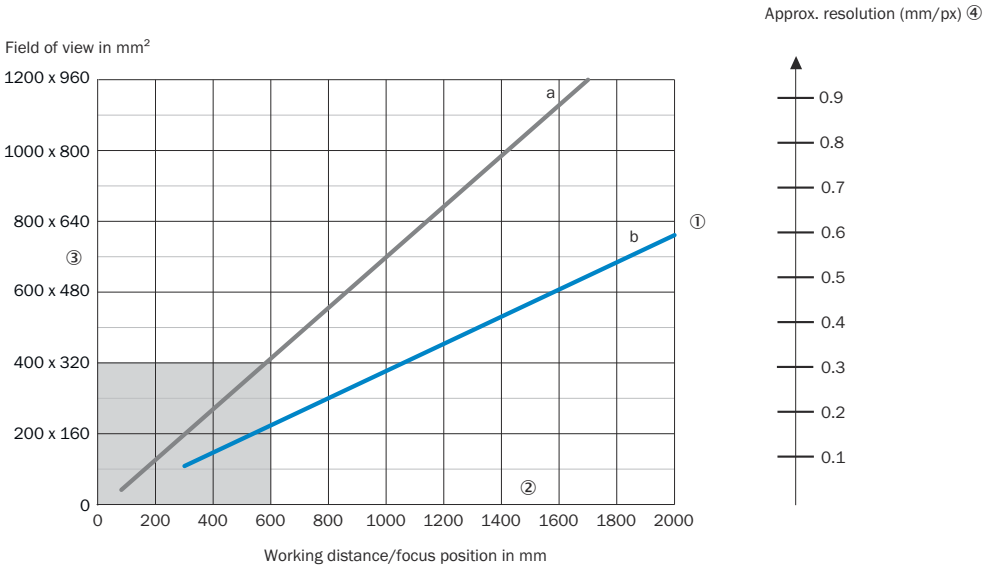
InspectorP632 S-mount

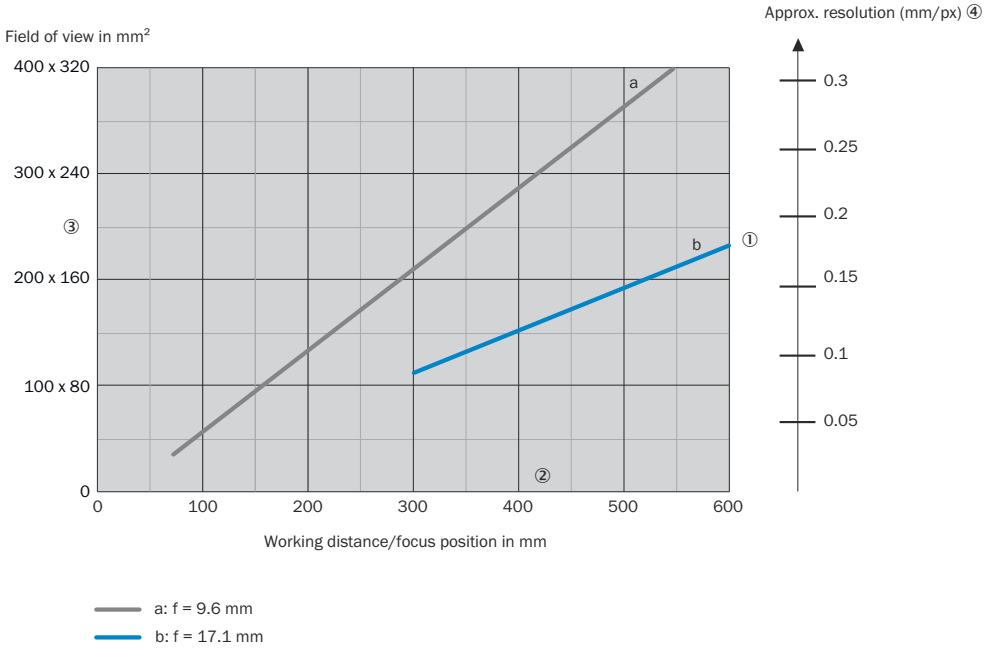




① Lens focal length
② Working distance in mm
③ Field of view in mm²

InspectorP62x

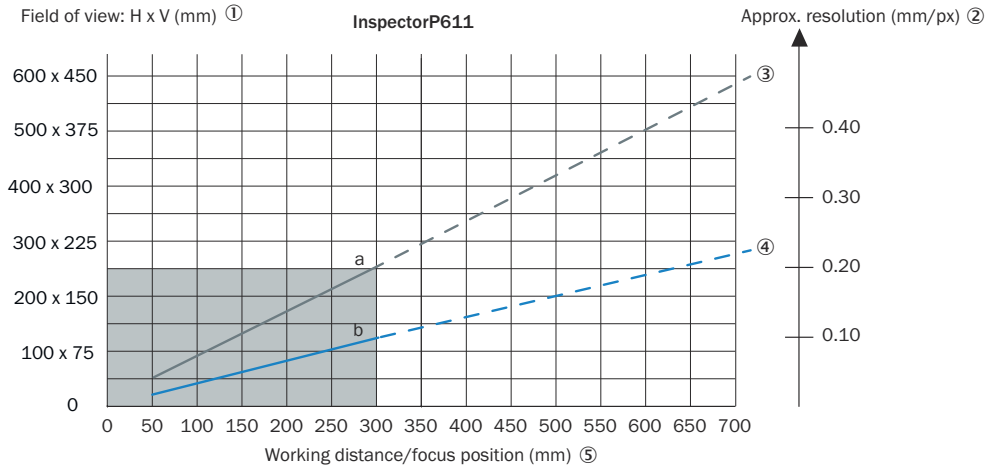


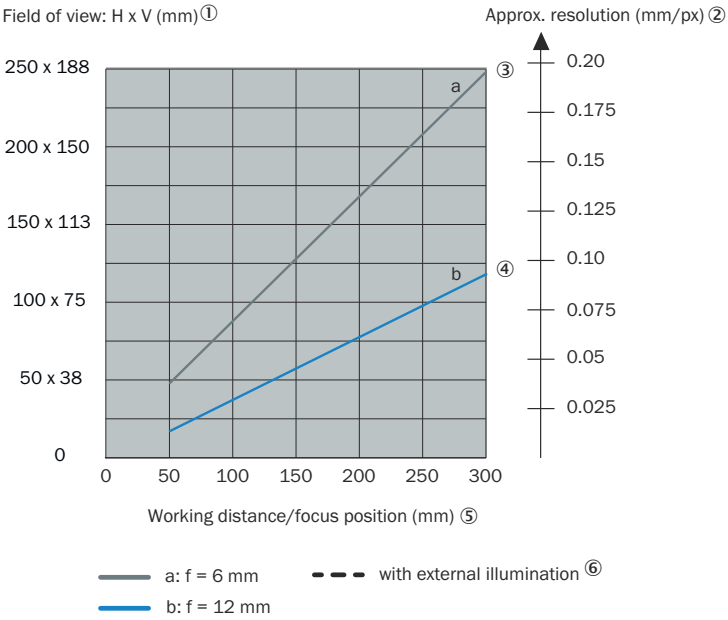


a: f = 9.6 mm
b: f = 17.1 mm

① Lens focal length
② Working distance in mm
③ Field of view in mm2
④ Approximate resolution in mm/px

InspectorP611





① Field of view: horizontal x vertical in mm

② Approximate resolution in mm/px

③ f = 6 mm. Solid line with internal illumination, and dashed line with suitable external illumination accessories.

④ f = 12 mm. Solid line with internal illumination, and dashed line with suitable external illumination accessories.

⑤ Working distance/focus position in mm

⑥ With external illumination

4 Transport and storage

4.1 Transport

NOTICE
Damage due to improper transport!

- The product must be packaged with protection against shock and damp.
- Recommendation: Use the original packaging.
- Note the symbols on the packaging.
- Do not remove packaging until immediately before you start mounting.

4.2 Transport inspection

Immediately upon receipt in Goods-in, check the delivery for completeness and for any damage that may have occurred in transit. In the case of transit damage that is visible externally, proceed as follows:

- Do not accept the delivery or only do so conditionally.
- Note the scope of damage on the transport documents or on the transport company's delivery note.
- File a complaint.

NOTE
Complaints regarding defects should be filed as soon as these are detected. Damage claims are only valid before the applicable complaint deadlines.

4.3 Storage

Store the device under the following conditions:

- Recommendation: Use the original packaging.
- Do not store outdoors.
- Store in a dry area that is protected from dust.
- So that any residual damp can evaporate, do not package in airtight containers.
- Do not expose to any aggressive substances.
- Protect from sunlight.
- Avoid mechanical shocks.
- Storage temperature: see "Ambient data", page 74.
- Relative humidity: see "Ambient data", page 74.
- For storage periods of longer than 3 months, check the general condition of all components and packaging on a regular basis.

5 Mounting

5.1 Mounting concepts

The device can be mounted in one of two ways:

- Mounted in a fixed position overlooking the robot cell. We call this a stationary sensor.
- Mounted to the robot. We call this a robot mounted sensor.

5.2 Overview of mounting procedure

The mounting of the device is divided into the following steps:

- Mount the device.
- Connect the device to interfaces and supply voltage.
- Adjust the device for the intended target area.

5.3 Preparation for mounting

5.3.1 Mounting requirements

NOTICE
Radio interference may occur when the device is used in residential areas!
Only use the device in industrial environments (EN 61000-6-4).

- Typical space requirement: See "Product characteristics", page 12 for type-specific field of view diagrams and dimensional drawings.
- Comply with technical data, such as the permitted ambient conditions for operation (e.g., temperature range, EM interference emissions, ground potential), see "Technical data", page 72.
- To prevent condensation, avoid exposing the device to rapid changes in temperature
- Protect from direct sunlight
- Ensure that there is good heat transfer from the device, in particular at high ambient temperatures (e.g., via the bracket to the mounting base or ensure that the back of the device is a sufficient distance from the wall of a housing)
- Only to be mounted using the threaded mounting holes provided for this purpose or the sliding nuts.
- Shock and vibration-free mounting
- Clear view of the objects to be detected

Equipment required

- Mounting device (bracket) with sufficient load-bearing capacity and suitable dimensions
- Two or four M5 screws for mounting on a mounting device supplied by the customer. Screw length is dependent on the mounting base (wall thickness of the bracket)
  When using an optional SICK bracket, the screws for mounting are included with delivery.
- Tool and tape measure

5.3.2 Mounting the device

The device is mounted using threaded mounting holes (M5) or sliding nuts.

The threaded mounting holes are located on the rear of the device.

The sliding nuts can each be inserted into a slot on the side of the housing.

SICK offers prefabricated brackets which are optimally suited for mounting the device in a wide range of applications (www.sick.com).

NOTE
In some instances, reflections can occur if the sensor is mounted perfectly perpendicular to the work plane. If a large white spot is seen in the sensor image, try to re-align the sensor to be 1 to 2 degrees off the perpendicular axis.

User-supplied brackets

A user-supplied bracket must meet the following requirements:

- Alignment of the device in the x and y axes can be adjusted
- The mounting device must be able to bear the weight of the device and connecting cables free of vibrations
- In mounting situations with strong vibrations, shock mounts may need to be provided
- Mounting options must be available for the 4 threaded mounting holes or the two sliding nuts

5.4 Mount the optics

NOTE
This mounting step is only required if the optional optics accessory has been included in the order for PLOC2D Flex. This does not apply for the Dynamic Focus type.

5.4.1 Mounting the lens and illumination unit

NOTICE
Possible impairment of image quality!
Dust and fingerprints on optical boundary surfaces can reduce image quality and may also affect the decoding performance of the device.

- ► When mounting the optics accessories, always ensure that the environment is free of dust.
- ► Do not touch the image sensor (CMOS) in the light inlet opening of the sensor or the glass lenses at either end of the lens unit.

NOTE
When mounting the optics accessories on the camera housing, always ensure that there is no power to the system.

Mount the optics

1. Place the camera housing on a nonslip base.
2. Remove the protective cap from the round light inlet.
3. If necessary, carefully insert the filter (optional) and spacer disk into the light inlet.
4. Screw the lens unit into the C-mount thread. This will also lock the optional filter in place at the same time (if applicable).

Mounting the illumination unit

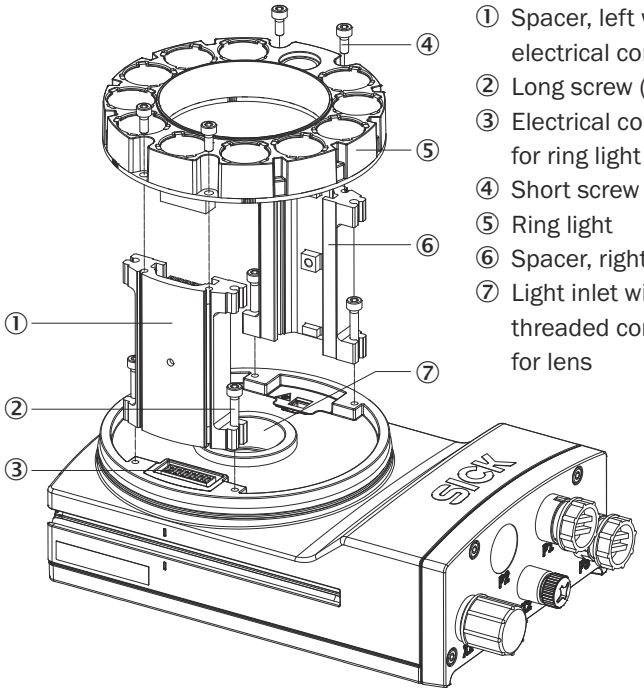
NOTICE

Risk of damage due to electrostatic discharge!

Electrostatic discharge from the human body may damage parts of the illumination unit or the camera housing.

The illumination variants for lenses with a focal distance of 12 mm or 16 mm do not feature any plastic lenses in front of the LEDs in the round recesses.

- ► Do not insert your fingers into the recesses.
- ► Do not touch the open contacts of the electrical connection for the illumination unit on the camera housing.



① Spacer, left with electrical connection
② Long screw (4 x)
③ Electrical connection for ring light
④ Short screw (4 x)
⑤ Ring light
⑥ Spacer, right
⑦ Light inlet with threaded connection for lens

1. Peel off the white protective sticker on the camera housing that covers the electrical connection ③ for the illumination unit.
2. Take two pairs of long screws and screw them into the threaded mounting holes to attach each spacer (① and ⑥) to the correct side of the camera housing.
3. Use the 4 short screws to attach the illumination unit ⑤ to the two spacers.
4. Manually preset the sharpness and aperture of the lens unit.
5. Mount the optics protective hood.

6 Electrical installation

6.1 Safety

6.1.1 Notes on electrical installation

NOTICE
Equipment damage due to incorrect supply voltage!

An incorrect supply voltage may result in damage to the equipment.

The device may only be powered using a voltage source that meets the following requirements:

- SELV: (EN / IEC 61010-1 or IEC 60950-1) or ES-1 (EN IEC 62368-1)

NOTICE
Equipment damage or unpredictable operation due to working with live parts!

Working with live parts may result in unpredictable operation.

- Only carry out wiring work when the power is off.
- Only connect and disconnect electrical connections when the power is off.

- **The electrical installation must only be performed by electrically qualified personnel.**
- **Standard safety requirements must be met when working on electrical systems!**
- Only switch on the supply voltage for the device when the connection tasks have been completed and the wiring has been thoroughly checked.
- When using extension cables with open ends, ensure that bare wire ends do not come into contact with each other (risk of short-circuiting when the supply voltage is switched on). Wires must be appropriately insulated from each other.
- Wire cross-sections in the supply cable from the customer's power system must be designed in accordance with the applicable standards. When this is being done in Germany, observe the following standards: DIN VDE 0100 (Part 430) and DIN VDE 0298 (Part 4), and/or DIN VDE 0891 (Part 1).
- Circuits connected to the device must be designed as SELV circuits (SELV = Safety Extra Low Voltage).
- Protect the device with a separate fuse at the start of the supply circuit.

NOTE
Layout of data cables

- Use screened data cables with twisted-pair wires.
- Implement the screening design correctly and completely.
- To avoid interference, e.g. from switching power supplies, motors, clocked drives, and contactors, always use cables and layouts that are suitable for EMC.
- Do not lay cables over long distances in parallel with power supply cables and motor cables in cable channels.

The enclosure rating for the device is only achieved under the following conditions:

- The cables plugged into the M12 connections are screwed tight.
- Any electrical connections that are not being used must be fitted with protective caps/plugs that are screwed tight (as in the delivery condition).

6.1.2 Wiring notes

NOTICE

Faults due to incorrect wiring.

Incorrect wiring may result in operational faults.

- For data transmission, use only screened cables with twisted-pair wires.
- Follow the wiring notes precisely.

NOTE

Preassembled cables can be found online at:

► www.sick.com

Power supply wiring requirements

Connector[1]	Max. fuse protection	Min. recommended cross-section[2]	Electromagnetic compatibility
A-coded	4 A	0.34 mm²	Use shielded cable
L-coded	16 A	1.5 mm²	Connect Functional earth wire

All electrical connections of the device are configured as round connectors. The IP65 protection class is only achieved with screwed plug connectors or cover caps.

Please observe the following wiring notes:

- A correct and complete cable shielding design is required for trouble-free data transmission.
- The cable shield must be connected at both ends in the electrical enclosure and at the device.
- The cable shield in the control cabinet must be connected to a large area of the signal ground, see figure 5, page 31).
- Appropriate measures must be taken to prevent equipotential bonding currents flowing through the cable shield.
- During installation, pay attention to the different cable groups. The cables are grouped into the following 4 groups according to their sensitivity to interference or radiated emissions.
  - Group 1: Cables very sensitive to interference, such as analog measuring cables
  - Group 2: Cables sensitive to interference, such as sensor cables, communication signals, bus signals
  - Group 3: Cables which are a source of interference, such as control cables for inductive loads, motor brakes
  - Group 4: Cables which are powerful sources of interference, such as output cables from frequency inverters, welding system power supplies, power cables
  - ► Cables in groups 1, 2, and 3, 4 must be crossed at right angles see figure 2, page 30
  - ► Cables in groups 1, 2, and 3, 4 must be routed in different cable channels or metallic separators must be used, see figure 3, page 30 and see figure 4, page 30. This applies particularly where cables of devices with a high level of radiated emission, such as frequency converters, are laid parallel to sensor cables.

1) see "Connectors and pin assignment", page 33
2) The supply cable from the power system must be designed in accordance with the applicable standards.

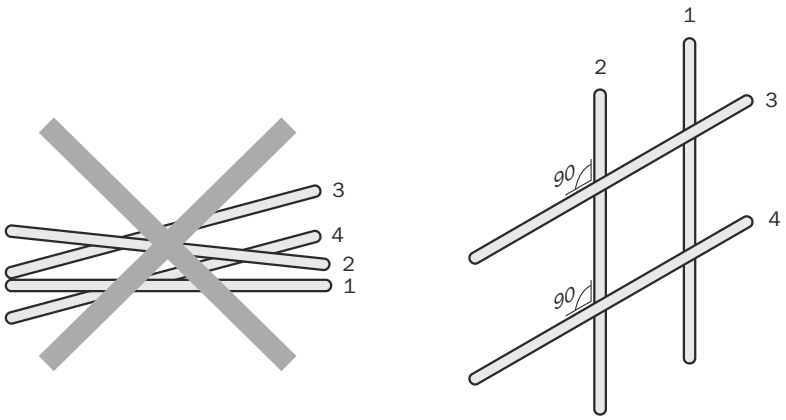


Figure 2: Cross cables at right angles

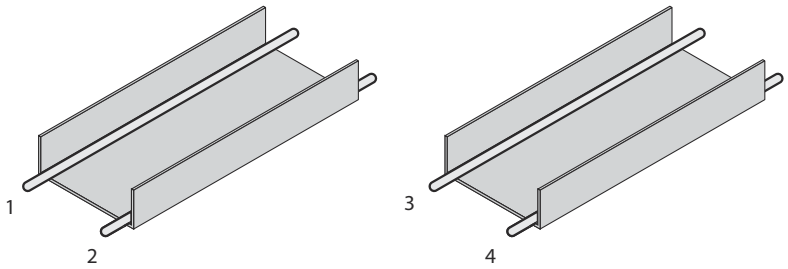


Figure 3: Ideal laying – Place cables in different cable channels

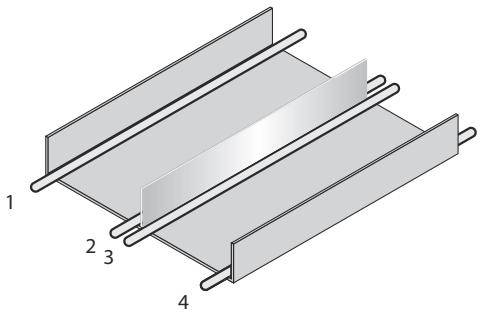


Figure 4: Alternative laying – Separate cables with metallic separators

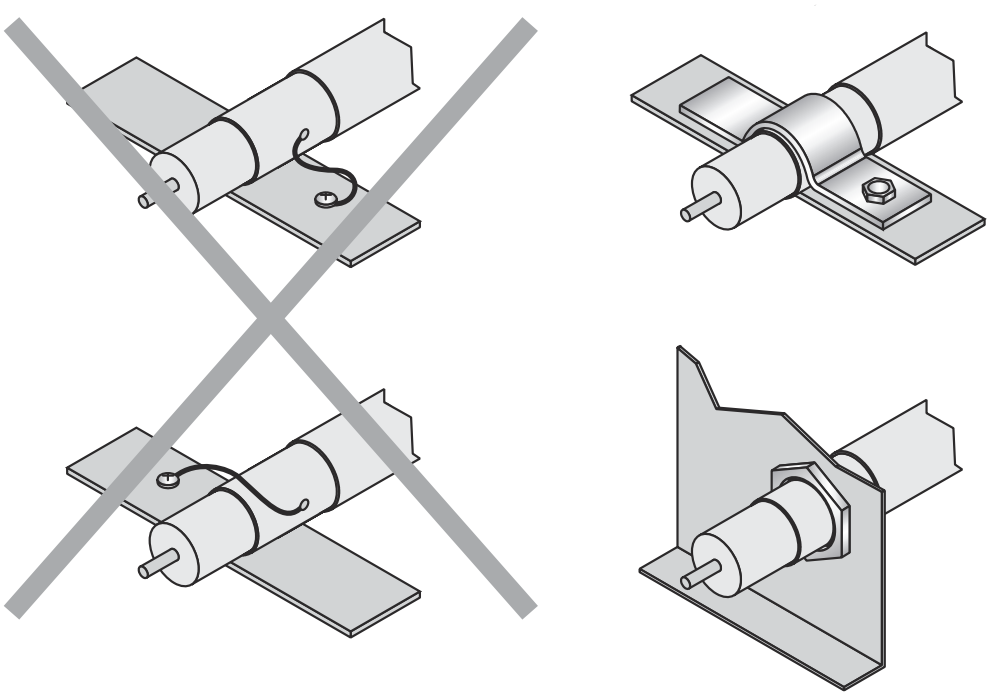


Figure 5: Make an extensive and low-impedance ground connection of the cable shield in the control cabinet.

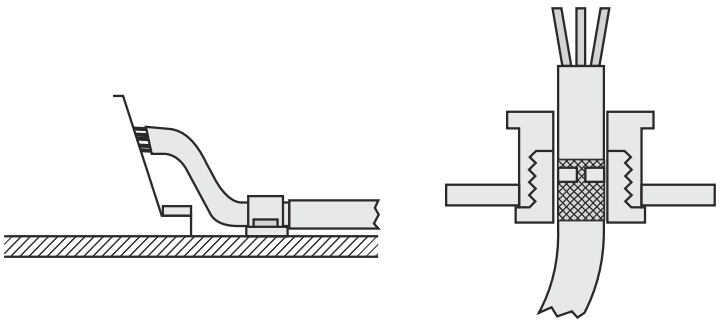


Figure 6: Shield connection in plastic housings

6.1.3 Prerequisites for the safe operation of the device in a system

WARNING
Risk of injury and damage caused by electrical current!

As a result of equipotential bonding currents between the SICK device and other grounded devices in the system, faulty grounding of the SICK device can give rise to the following dangers and faults:

- Dangerous voltages are applied to the metal housings
- Devices will behave incorrectly or be destroyed
- Cable shielding will be damaged by overheating and cause cable fires

Remedial measures

- ► Only skilled electricians should be permitted to carry out work on the electrical wiring.
- ► Ensure that the ground potential is the same at all grounding points.
- ► If the cable insulation is damaged, disconnect the voltage supply immediately and have the damage repaired.
- ► Where local conditions are unfavorable and therefore do not meet conditions for a safe grounding method (same ground potential at all grounding points), take measures in accordance with the following formats.

The device is connected to the peripheral devices (voltage supply, any local trigger sensor(s), PLC) via shielded cables. The cable shield – for the data cable, for example – rests against the metal housing of the SICK device. The device can either be grounded through the cable shield or through one of the threaded mounting holes.

If the peripheral devices have metal housings and if the cable shields also lie on their housings, it is assumed that all devices involved in the installation have the **same ground potential**.

This is achieved by complying with the following conditions:

- Mounting the devices on conductive metal surfaces
- Correct grounding of the devices/metal surfaces in the system.
- If necessary: low-impedance and current-carrying equipotential bonding between areas with different ground potentials

If these conditions are not fulfilled, equipotential bonding currents can flow along with the cable shielding between the devices due to differing ground potentials; this can be dangerous. This is, for example, possible in cases where there are devices within a widely distributed system covering several buildings.

Remedial measures

The most common solution to prevent equipotential bonding currents on cable shields is to ensure low-impedance and current-carrying equipotential bonding. If this is not possible, the following solution approaches serve as a suggestion.

NOTICE
We expressly advise against opening up the cable shields. This would mean that the EMC limit values can no longer be complied with and that the safe operation of the device data interfaces can no longer be guaranteed.

Measures for widely distributed system installations

On widely distributed system installations with correspondingly large potential differences, the setting up of local islands and connecting them using commercially available **electro-optical signal isolators** is recommended. This measure achieves a high degree of resistance to electromagnetic interference.

The use of electro-optical signal isolators between the islands isolates the ground loop. Within the islands, a stable equipotential bonding prevents equalizing currents on the cable shields.

Measures for small system installations

For smaller installations with only slight potential differences, insulated mounting of the SICK device and of peripheral devices may be a sufficient solution.

Even in the event of large differences in the ground potential, ground loops are effectively prevented. As a result, equalizing currents can no longer flow via the cable shields and metal housing.

NOTICE

The power supply for the SICK device and the connected peripheral devices must also guarantee the required level of insulation.

Under certain circumstances, a tangible potential can develop between the insulated metal housings and the local ground potential.

6.2 Connectors and pin assignment

Connectors

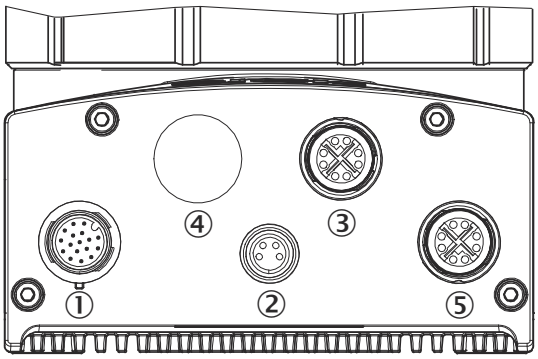


Figure 7: InspectorP65x connectors

① Power and I/O
② USB (not used)
③ Ethernet (not used)
④ -
⑤ Ethernet, 8-pin

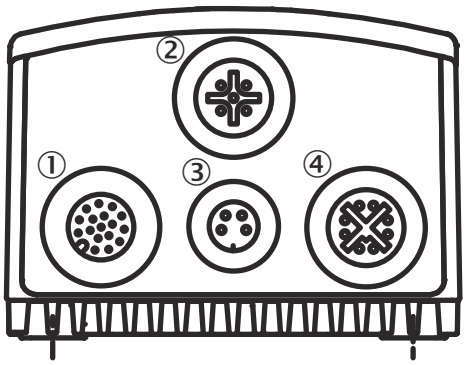


Figure 8: InspectorP63x connectors

① Power and I/O
② External illumination

③ USB (not used)
④ Ethernet, 8-pin

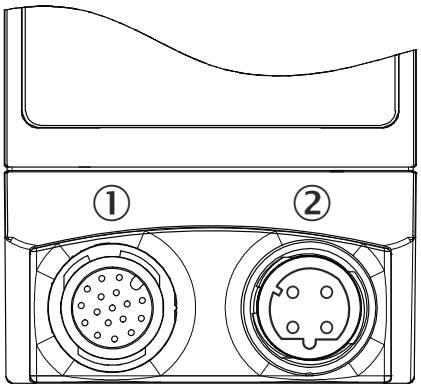


Figure 9: InspectorP62x connectors

① Power and I/O
② Ethernet, 4-pin

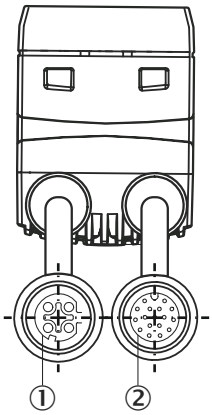
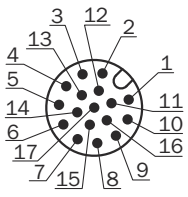
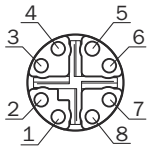
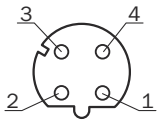
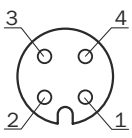


Figure 10: InspectorP611 connectors

① Ethernet, 4-pin
② Power and I/O

Pin assignments

Pin	Power and I/O	Ethernet, 8-pin	Ethernet, 4-pin	External illumination
	 17-pin M12 male connector, A-coded	 8-pin M12 female connector, X-coded	 4-pin M12 female connector, D-coded	 4-pin M12 female connector, A-coded
1	GND	TRD0_P	TD+	DC 24 V switchable output
2	DC 24 V ± 20%	TRD0_N	RD+	Trigger illumination DC 24 V
3	CAN L	TRD1_P	TD–	GND
4	CAN H	TRD1_N	RD–	Not connected
5	TD+ (RS-422), Host	TRD3_P	–	–

Pin	Power and I/O	Ethernet, 8-pin	Ethernet, 4-pin	External illumination
6	TD– (RS-422), Host TxD (RS-232), Host	TRD3_N	–	–
7	TxD (RS-232), Aux	TRD2_P	–	–
8	RxD (RS-232), Aux	TRD2_N	–	–
9	SensGND	–	–	–
10	Sensor 1 switching input	–	–	–
11	RD+ (RS-422), Host	–	–	–
12	RD– (RS-422), Host RxD (RS-232), Host	–	–	–
13	Out1	–	–	–
14	External illumination output	–	–	–
15	In2	–	–	–
16	Conveyor tracking output	–	–	–
17	Out4	–	–	–

6.3 Connecting the device

6.3.1 Connection diagram

Connection principle

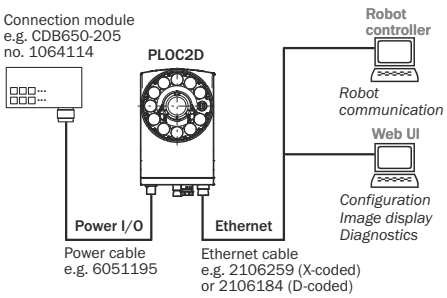


Figure 11: General connection principle

When PLOC2D is used with a CDB650 connection module, connect **External illumination trigger output** (pin 14) to terminal 21 and **Conveyor tracking output** (pin 16) to terminal 50.

Wiring without a SICK connection module

For use with a custom connection unit, see "Connectors and pin assignment", page 33.

6.3.2 Wiring the data interface

Wiring the Ethernet interface

To connect the sensor to the PC:

1. Connect the sensor to the PC via Ethernet.

To connect the sensor to the PC and the robot controller:

1. Connect the sensor to a network switch by an Ethernet cable.
2. Connect the network switch to the PC via Ethernet.
3. Connect the network switch to the robot controller via Ethernet.

NOTE

The Ethernet interface for the device has an Auto-MDIX function. This automatically adjusts the transmission speed as well as any necessary crossover connections.

6.3.3 Conveyor tracking

Connect the robot controller to pin 16 on the **Power and I/O** connector (terminal 50 on CDB650-204) to activate conveyor tracking, which allows the robot controller to synchronize the conveyor encoder with the exact time for an image exposure.

Conveyor tracking principle

The robot controller sends a `Run.Locate` command to the PLOC2D to start the part localization, see "Commands", page 60. Each part localization consists of one or more image exposures, depending on how many jobs are being located and if the jobs use different image settings (see Image acquisition). The jobs using the same image exposure settings are located within the same image. If there are multiple image exposure settings in the command, one image is acquired for each exposure setting and its connected jobs.

The conveyor tracking signal is high during each image exposure, which means that one or more signal pulses will be sent as output to the robot controller. The robot controller should trigger on the leading edge of the control signal pulse, which is when the exposure for the image starts. The length of the signal pulse depends on the image exposure settings.

The robot controller records an index for each exposure with the corresponding encoder value for the conveyor. Each `Run.Locate` response from the PLOC2D includes an image exposure index (`exposure`), see "Responses", page 64. The index makes it possible to map the located part to its position on the conveyor.

Example with multiple exposure settings

An example to illustrate the case of locating jobs with multiple exposure settings and exposure index with conveyor tracking. In this example part localization for three jobs (job 3, 1, and 2) are applied. Job 1 and 3 use the same image exposure settings.

1. `Run.Locate,3 1 2` command to the PLOC2D.
   - Job 1 and 3 use the same image exposure settings.
2. The leading edge of the tracking signal pulse, the robot controller records the conveyor's encoder value.
3. The tracking signal is high.
   - Image exposure settings for job 1 (and 3).

✓ Image acquired, exposure index 1.

4. The tracking signal is low.
5. The leading edge of the tracking signal pulse, the robot controller records the conveyor's encoder value.
6. The tracking signal is high.
   - Image exposure settings for job 2.

✓ Image acquired, exposure index 2.

7. The tracking signal is low.
8. Part localization for the jobs.

✓ The best part localization result is in the response (including which exposure index) from the PLOC2D.

6.3.4 External illumination

Connect the external illumination to pin 14 on the **Power and I/O** connector. If you use the CDB650-204 connection module, the external illumination is available on terminal 21.

On PLOC2D-63x devices, you can also use the separate external illumination connection, see "Device view (InspectorP63x)", page 13.

7 Operation

7.1 PLOC2D user interface

7.1.1 Accessing the user interface

PLOC2D uses a web based user interface. To access the interface, follow the steps below:

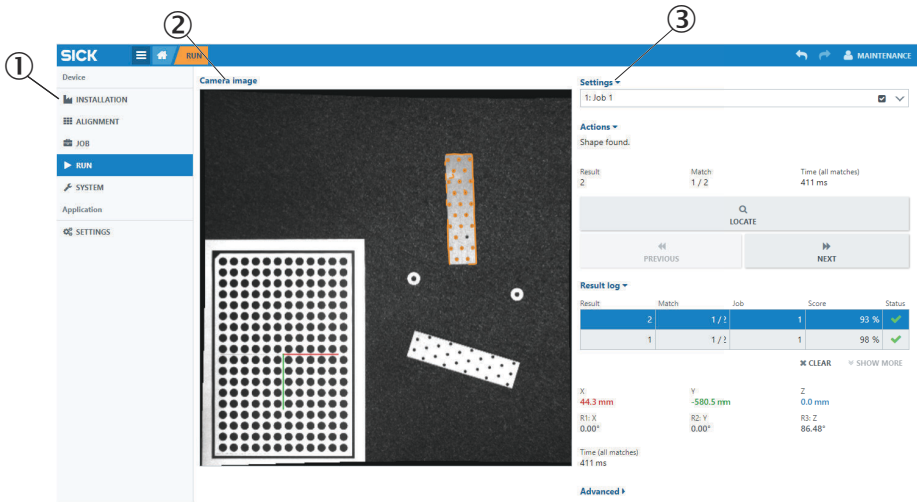
1. Open a web browser window.
2. Type the preset IP address: 192.168.0.1.

NOTE

Make sure that the network communication settings on the computer are correctly set up:

- The computer must be on the same network as the PLOC2D.
- The computer must not use the same IP address as the PLOC2D.

7.1.2 Overview of the user interface



① Page selection panel
② Camera image viewer
③ Settings panel

The PLOC2D user interface consists of the following parts:

- The Page selection panel, which contains workflow steps and system settings.
- The camera image viewer, where images are displayed.
- The Settings panel, which displays settings for the currently selected workflow step.

7.1.3 User levels

At the first use of the interface, the user is automatically logged in with user level **Run**.

Click the user symbol in the upper right part of the user interface to log in with a different user level.

The following user levels are available:

User level	Description
Run (no password)	Default first-time login. Monitor production by viewing localization results or system log. **Run** and **System** workflow steps are visible but no changes are possible.
Operator (no password)	Verify that pre-configured jobs work before starting a new production batch. Unlocks **Run** workflow step. **Job** and **System** workflow steps are visible but no changes are possible.
Maintenance (password: main)	Adjust image acquisition settings, perform hand-eye alignment, configure jobs and change system settings. Unlocks **Installation**, **Alignment**, **Job**, **Run** and **System** workflow steps.
Service (password: servicelevel)	Calibrate the PLOC2D sensor. Unlocks **Calibration** workflow step and a few other advanced options.

7.2 Configuration workflow

User level **Service** is required to do a complete configuration of the PLOC2D sensor. User level **Maintenance** is required for configuration of pre-calibrated PLOC2D variants, which do not need calibration.

The PLOC2D configuration consists of the following steps:

Workflow step	Description
Installation	Aim the sensor and optimize the focus and aperture for the intended working distance.
Calibration	Calibrate the system to compensate for any camera and system distortion.
Alignment	Align the sensor and robot coordinate systems using an alignment target.
Job configuration	Acquire a reference image and teach a reference part for each job.
Run jobs	Confirm that the PLOC2D sensor locates the parts of interest.

Illumination setup

Before starting the configuration, make sure that the illumination is correctly set up. For details, see "Illumination settings", page 56.

External communication interfaces

All external communication interfaces are disabled by default. The applicable communication interfaces need to be manually enabled for communication to be possible, see "System settings", page 53.

7.2.1 Installation

Acquire image

The purpose of this workflow step is to acquire an image, in order to aim the rigged sensor or evaluate the image. User level **Maintenance** or higher is required.

1. In the user interface, go to the **Installation** page.
2. Click **Auto adjust exposure** in the **Advanced** section to update the image exposure settings.
3. Click the **Show aiming laser** toggle and confirm that the sensor is mounted in an appropriate position above the target surface.
4. Click **Acquire** for a single image, or **Continuous** for a stream of images.

Adjust focus

The purpose of this workflow step is to aim the rigged sensor and optimize the focus and aperture for the intended working distance. User level **Service** is required.

NOTICE
Do not try to change focus and aperture settings on a pre-calibrated camera.

1. In the user interface, go to the **Installation** page.
2. Click **Auto adjust exposure** in the **Advanced** section to update the image exposure settings.
3. Click the **Show aiming laser** toggle and confirm that the sensor is mounted in an appropriate position above the target surface.
4. Click the **Adjust camera focus** toggle to enable the **Camera focus** curve with a continuous acquisition of images.

✓ A blue focus region is displayed in the image window.

5. Click and hold to move the focus region. Preferably to a sharp edge with light and dark pixels on the intended working distance.

✓ The **Camera focus** curve (see figure 12) shows the analyzed quality in the focus region with a blue line.
The green line shows the highest and best value acquired.

6. Adjust the focus until the focus region looks sharp and the **Camera focus** curve has reached a plateau as high as possible.
   - Sensor with manual focus: adjust the aperture and focus rings on the sensor or with the included tool for some sensors.
   - Sensor with electric focus: adjust the focus with the **Focus distance** slider or click **Auto adjust focus**.

NOTE
When adjusting the focus, move the focus ring or slider to one end, and slowly move it to the other end. The green line has now captured the maximum focus value. Move the ring/slider back to where the blue line meets the green for finetuning of the focus.

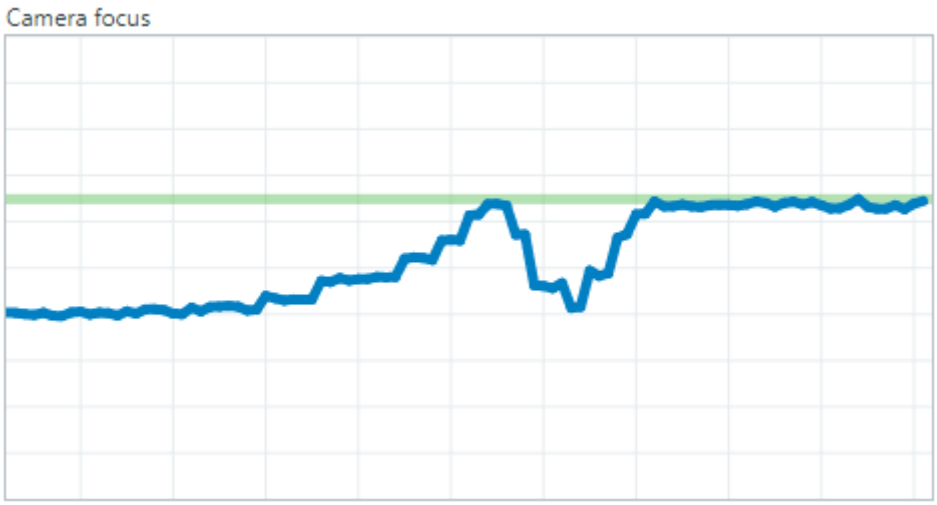


Figure 12: Camera focus curve

7.2.2 Calibration

NOTICE
Calibration must not be performed on pre-calibrated PLOC2D variants.

The purpose of the calibration is to compensate for the internal camera and lens system distortion in order to locate parts with high accuracy. This is achieved by measuring a well-defined calibration target in different poses and estimating the internal camera parameters based on these measurements. User level **Service** is required.

A successful calibration procedure is crucial in order to obtain valid part localization results.

Calibration target

NOTE
For best performance it is recommended to use one of the official targets, see PLOC2D version accessories at www.sick.com/PLOC2D.

The calibration target should preferably cover the field of view at the intended working distance.

For evaluation purpose, it is possible to download a printable PDF file of the selected target by clicking  in the user interface, **Calibration** page. The target image must be printed at 100% scale and glued to a flat non-flexible surface.

NOTE
Depending on lens and intended working distance it could be difficult to cover the entire field of view in every image if the calibration target is smaller than the field of view. Minimizing the aperture allows placing the calibration target closer to the camera, but results in darker images.

Pre-requisites

Make sure the following before starting the calibration procedure:

- Suitable calibration target.
- The aperture is set to a suitable value.
- The camera is focused on the intended working distance.

Procedure

In the user interface, go to the **Calibration** page.

A good calibration requires a number of images that show the calibration target in different poses that together cover the entire field of view. Ideally, each part of the field of view should be covered with calibration target data at least three times at different tilt angles. If possible, cover the entire field of view in every image.

The calibration procedure consists of the following steps:

- Collect image data.
- Start calibration.
- Check results.

Collect image data

1. Click **Auto adjust exposure** in the **Advanced** section to update the image exposure settings.
2. Select the correct calibration target in the **Calibration target** list.
3. Click **Acquire** or **Continuous** in the user interface to acquire calibration images.
4. For each image acquisition, place the calibration target in a new position and with a new tilt angle in the camera's field of view. Tilt by lifting a different corner of the calibration target for each image.

✓ A colored circle and a colored grid are displayed in the image window to indicate

the progress (see figure 13, figure 14 and figure 15):

- The fill level of the circle represents the overall coverage (%) of the field of view.
- The grid represents the coverage in the different regions of the field of view:
  - Each time a region is covered with calibration target data, the grid gradually changes color from orange to green.
  - When a region has been covered with calibration target data three times, the grid disappears.

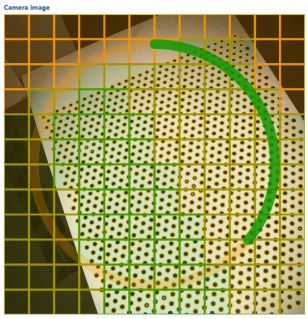


Figure 13: 30% coverage

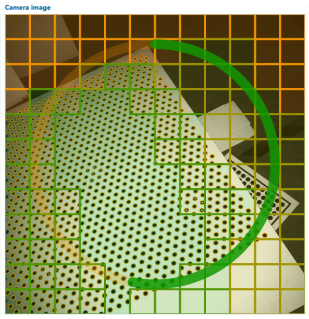


Figure 14: 50% coverage

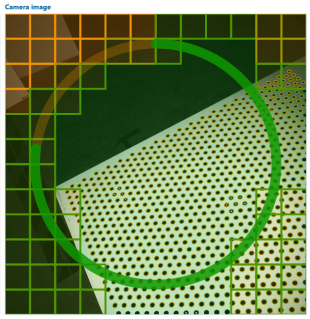


Figure 15: 80% coverage

5. Collect as many images as necessary for good coverage of the field of view, up to 32 images.
   An image will only be added to the calibration image set if the target can be accurately located, which is indicated in the image window by in-painted calibration marks.

Click **Previous** and **Next** to browse the calibration images. Click **Remove** to remove an image from the image set. Click **Remove all** to remove all images.

Start calibration

Once a good calibration image set has been collected, click **Calibrate** to start the calibration. Note that the calibration may take up to a few minutes.

Calibration results

When the calibration is finished, the results are displayed in the **Active calibration** section in the user interface (see figure 16).

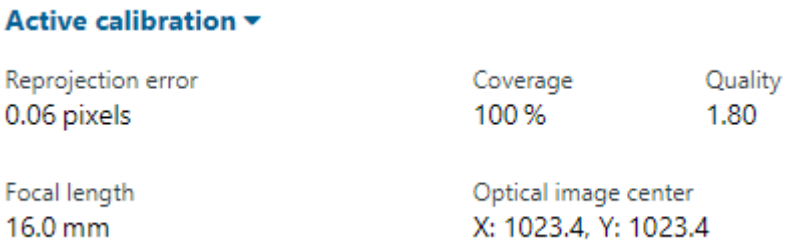


Figure 16: Calibration results

The goal of the calibration is to achieve high coverage and a low reprojection error, see table 1. Plausibility checks on estimated focal length and optical image center are recommended.

Table 1: Result parameters

Parameters	Description
Reprojection error	This parameter should be as low as possible. The reprojection error depends on the coverage; a higher coverage normally yields a higher reprojection error. As a general rule, a reprojection error < 1 is recommended.
Coverage	This parameter indicates how much of the field of view has been covered by the detected calibration marks.
Quality	This parameter should be as high as possible, preferably > 1. To obtain a good calibration, it is important to find a good balance between high coverage and low reprojection error.
Focal length	This parameter is the focal length estimated by the system. It should not be very far from the specification of the lens.
Optical image center	This parameter represents the pixel coordinates of the estimated optical center. It should be close to the actual center of the image.

7.2.3 Hand-eye alignment

The purpose of this workflow step is to align the sensor and robot coordinate systems. You will be using an alignment target. User level **Maintenance** or higher is required.

NOTE
For best performance it is recommended to use one of the official targets, see PLOC2D version accessories at www.sick.com/PLOC2D.

For evaluation purpose, it is possible to download a printable PDF file of the selected target by clicking  in the user interface, **Alignment** page. The target image must be printed at 100% scale and glued to a flat non-flexible surface.

The alignment target is illustrated in figure 17. Note that the illustration is not to scale and can not be used for alignment.

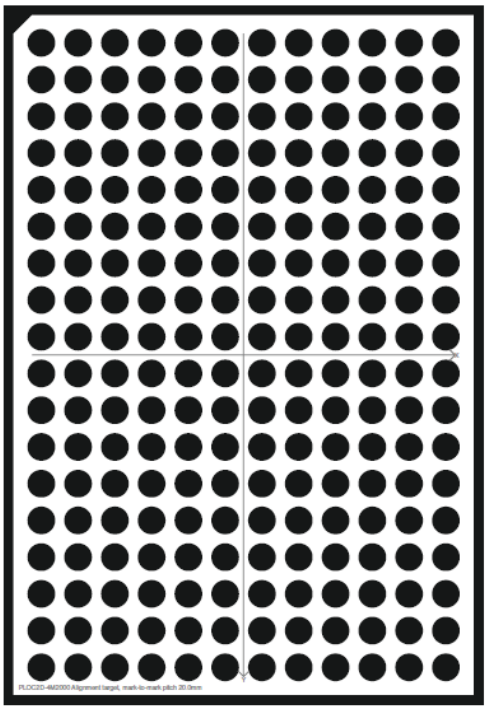


Figure 17: Example of a PLOC2D alignment target

7.2.3.1 Stationary sensor

If you use a stationary sensor, the coordinate systems are aligned to one or more predefined work planes. The alignment procedure requires that the robot is manually jogged to specified points on the alignment target. The result will be expressed in coordinates relative to the defined work plane.

Align to a work plane

You can align the sensor to 16 different work planes.

1. In the user interface, go to the **Alignment** page.
2. Click **Auto adjust exposure** in the **Advanced** section to update the image exposure settings.
3. In the **Alignment of** list, click the work plane you want to align the sensor to.
4. In the **Alignment target** list, click the alignment target you are using.
5. Place the alignment target on the target surface in the same plane and at the same height as the parts to be located.
6. Position the alignment target to allow the robot to measure the work frame as defined by the coordinate system on the target. The target should be completely visible in the camera image.
7. Click **Align** to acquire an image and align the sensor coordinate system with the alignment target.
8. If alignment fails, adjust the exposure settings to obtain a clear image.
9. Repeat steps 6. – 8. until an "Alignment successful" message is displayed in the user interface.

NOTE
Do not remove or reposition the alignment target after sensor alignment until the robot work plane has been defined.

10. Define the robot work plane by jogging the robot to the alignment target points indicated by the arrows (x-axis in red, y-axis in green, z-axis in blue) in figure 18

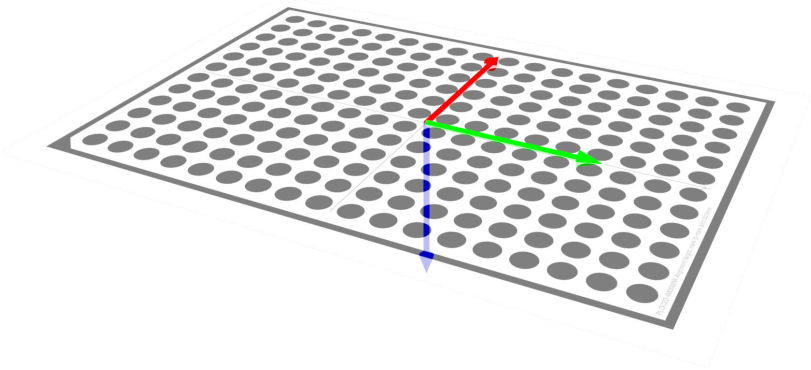


Figure 18: Work plane alignment base

Results

When the sensor is aligned to the work plane, an image of the alignment target is displayed in the image window. The displayed image is rectified, that is, projected onto the defined work plane. A blue circle, representing the position and the direction of the alignment target, is displayed on top.

The aligned sensor coordinates are displayed in the **Results** section.

7.2.3.2 Robot mounted sensor

If you use a robot mounted sensor, the sensor automatically calculates how it is mounted to the robot arm. The sensor must also be aligned to one or more predefined work planes. Results will be expressed in robot coordinates.

NOTE

The commands `Alignment.HandEye.Pose.Add` and `Alignment.Align` must always include the position and rotation of the robot's flange from the default origin of the robot (usually the robot base) when the sensor is robot mounted.

Calculate sensor position on the robot arm

The procedure comprises acquiring images of an alignment target from different poses with the sensor mounted to the robot arm. We recommend at least 4 different poses.

1. In the user interface, go to the **Alignment** page.
2. Click **Auto adjust exposure** in the **Advanced** section to update the image exposure settings.
3. In the **Alignment of** list, click **Robot TCP → PLOC2D**.
4. In the **Alignment target** list, click the alignment target you are using.
5. Position the alignment target in the robot cell. The target should be completely visible in the camera image.
6. Send an `Alignment.HandEye.Pose.Add` command with the current robot position.
7. Move the robot to a new pose. Do not move the alignment target. The target should be completely visible in the camera image.

8. Send an `Alignment.HandEye.Pose.Add` command with the current robot position.
9. Repeat steps 7.– 8. at least two times.
10. Click **Calculate** to calculate the sensor position on the robot arm.

✓ When the calculation is finished, the results are displayed in the **Results** section in the user interface.

✓ System setting **Mounting type** is automatically set to **Robot**, see "Mounting type", page 55.

Align to a work plane

You can align the sensor to 16 different work planes. The robot pose for each work plane is a default pose going forward in the configuration and operation of the system. This position and rotation of the robot will be referenced as the work plane robot pose.

1. In the user interface, go to the **Alignment** page.
2. In the **Alignment of** list, click the work plane you want to align the sensor to.
3. In the **Alignment target** list, click the alignment target you are using.
4. Place the alignment target on the target surface in the same plane as the parts to be located. The target should be completely visible in the camera image.
5. Click **Auto adjust exposure** in **Advanced** to update the image exposure settings.
6. Send an `Alignment.Align` command with the current robot position.
   - If **Align** fails, check the **System log** to get more information. Adjust and send the command again.

✓ "Alignment successful" message is displayed in the user interface.

7. Save the work plane robot pose in the robot program for this specific work plane.

7.2.3.3 Edit workplane description

1. Click  .
2. Enter a new workplane description (name).
3. Click  .
4. The workplane has a new description.

7.2.3.4 Define an exclusion region

An exclusion region is a part of the work plane where no parts are ever reported as results. This is useful if some region of the work plane often causes false matches. For example, an edge of a conveyor belt. All jobs using this work plane will benefit from the exclusion region

Draw an exclusion region

- Click **Brush** to draw an exclusion region. See figure 19.
  - Use the mouse scroll wheel or the **+** and **-** keys to adjust the size of the **Brush** tool.
  - Zoom by pressing **Shift+Up arrow** or **Shift+Down arrow**.
  - Pan the zoomed view with the arrow keys.
  - Click **Eraser** to remove parts of the region.
  - Click **Clear** to remove the whole region.

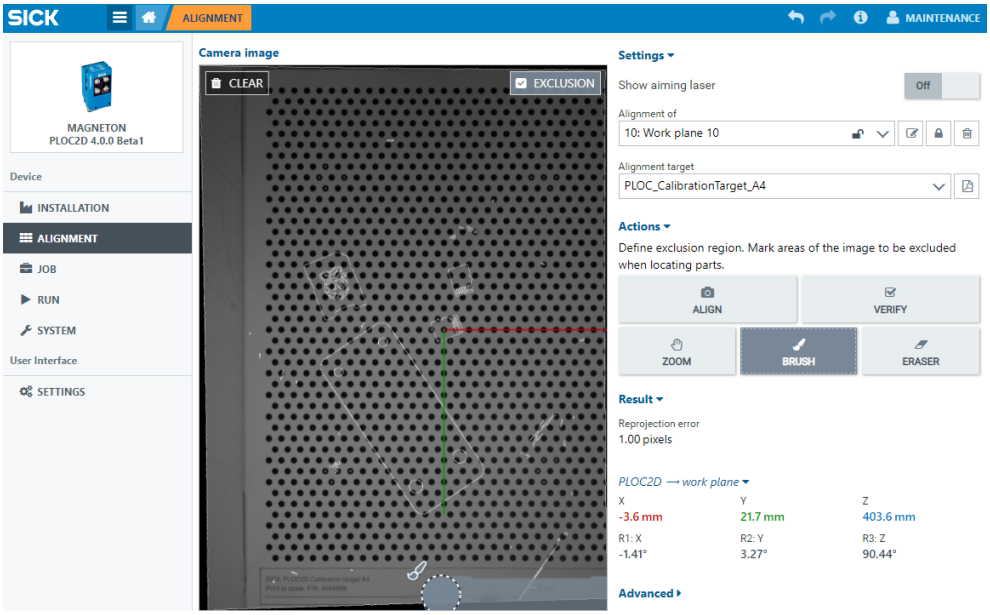


Figure 19: Work plane exclusion region

7.2.3.5 Pixel size

The pixel size is by default automatically calculated per alignment of the current work plane.

The pixel size can be adjusted with the **Pixel size** slider after alignment. User level **Service** is required. The setting will be applied to all jobs connected to the current work plane that was aligned.

Preserve pixel size can be enabled to avoid the automatic re-calculation of all connected jobs when re-aligning the current work plane. User level **Service** is required. When enabled, it will lock in the **Pixel size** and its slider.

7.2.3.6 Verify alignment

Verify alignment to confirm that the PLOC2D sensor has not moved after the sensor has been aligned to a work plane or its position on the robot arm has been calculated. The alignment target must also be in the same position.

Click **Verify** to capture an image and confirm that the alignment target is found in the expected position.

Verification threshold

Use the **Verification threshold** slider to set the tolerance for how much the sensor and the alignment target are allowed to move in relation to each other. User level **Service** is required.

Figure 20: Verification threshold slider

7.2.4 Job configuration

The purpose of this workflow step is to configure a job for each part type to be located. User level **Maintenance** or higher is required.

For each job configuration, a reference image is acquired and a reference part is located. The job must be configured on an aligned work plane. A maximum of 320 jobs can be configured.

To clear a job

- To clear all data from a job, click .

To edit the job description

1. Click .
2. Enter a new job description (name).
3. Click .
4. The job has a new description.

To unlock and lock a job

1. Click to unlock the job. A new job is unlocked by default.
2. Edit job settings.
3. Click to lock the job, to prevent unintended modifications.

Zoom view

- Click **Zoom** to zoom the camera view by:
  - Rotating the mouse scroll wheel.
  - Pressing **Shift+Up arrow** or **Shift+Down arrow**.
- To zoom to the whole image click .
- Pan the zoomed-in camera view by:
  - Dragging the image.
  - Pressing the arrow keys.

7.2.4.1 Job configuration workflow

Overview of the job configuration alternatives

- **Stationary sensor, option 1**: The pick pose of the part is defined relative to the work plane alignment base and saved in the robot program. This is a relative pick pose with both position and rotation on all axes. This option is recommended for more complex or serial robot movements.
  Note: Do not use the part reference point tool to adjust the pick pose, an incorrect offset will be added to the absolute pick position from the tool.
- **Stationary sensor, option 2**: The pick pose of the part is defined with a part reference point tool in the PLOC2D UI for the current work plane. This is an absolute pick position, with X and Y axis position and only Z axis rotation (the Z axis position is defined by the work plane). This option is recommended for straight-forward part picking with the robot.
- **Robot mounted sensor**: The pick pose of the part is defined by a part reference point robot command for the current work plane. The pick pose can be adjusted with the part reference point tool.

Job configuration

1. In the user interface, go to the **Job** tab.
2. Select a job in the **Job** list.
3. Select a work plane in the **Work plane** list.
4. Adjust **Score threshold** if needed.

- The PLOC2D sensor assigns a percentage score to each located part. Only parts with scores above the score threshold will be reported.

5. Place the reference part in the sensor's field of view.

NOTE
Note that the part must remain in this position until the job configuration is finished, or otherwise instructed.

6. Depending on chosen alternative:
   - **Stationary option 1:** Jog the robot to the pick pose for the part. Save the pick pose in the robot program from the origin of the work plane alignment base.
   - **Stationary option 2:** Continue with next step. The pick pose is later defined in step 10..
   - **Robot mounted:** Set the pick position, see "Robot mounted sensor", page 48.
7. Adjust settings in the **Advanced** section, see Image acquisition and Algorithm.
8. Click **Acquire** to acquire a reference image.

✓ The displayed reference image is rectified, that is, projected onto the selected work plane.

9. Define a part shape region, see Draw a part shape region.

Optional:

10. Set or adjust the pick position with the part reference point tool, see Adjust the pick position.
11. Define a gripper clearance region, see Draw a gripper clearance region.
12. Define a job exclusion region, see Draw a job exclusion region.

7.2.4.2 Robot mounted sensor

Set the pick position for robot mounted sensor

1. Jog the robot and place the gripper in the intended pick pose relative to the part.
2. Send a `Job.PartReferencePoint.Set` command with the position and rotation of the gripper tool center point from the default origin of the robot (usually the robot base).

✓ The part reference point should now be updated in the web UI.

3. Move the robot to the work plane robot pose.
4. Continue with Job configuration from step 7.

7.2.4.3 Define regions

Jobs include part shape regions and may include one or more gripper clearance regions and exclusion regions.

Click **Brush** to start editing the regions.

Draw a part shape region

The part shape regions define features of the reference part image that the RG-system will locate.

- Click **Part shape** to select the part shape region layer. The part shape region is orange.
- Click **Brush** to draw a region that covers a feature of the reference part. See figure 21.
  - Use the mouse scroll wheel or the **+** and **-** keys to adjust the size of the **Brush** tool.
  - Zoom by pressing **Shift+Up arrow** or **Shift+Down arrow**.
  - Pan the zoomed view with the arrow keys.
  - Click **Clear** to remove the applied region.

- It is also possible to automatically draw a part shape region using a background image.
  - Click **Acquire** to acquire a reference image of the part.
  - Remove the part from the sensor's field of view.
  - Click **Auto** to automatically draw a part shape region based on the differences between the reference image and the background image.
  - The region can then be adjusted by clicking **Brush**.

✓ When the system locates the part, a "Job configured" message is displayed in the user interface and the part contours are highlighted in the image window. See figure 22.

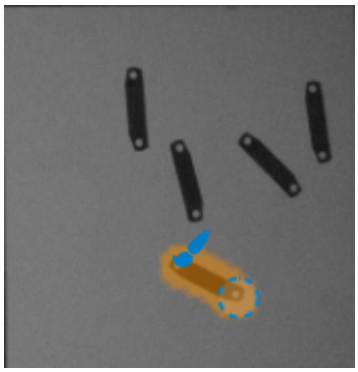


Figure 21: Draw a part shape region

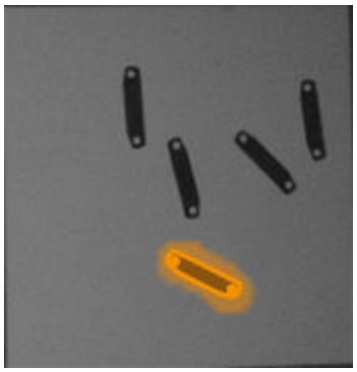


Figure 22: Highlighted part contours

- If needed, click **Eraser** to manually erase regions that do not belong to the reference part. See figure 23.
  - Use the mouse scroll wheel or the **+** and **-** keys to adjust the size of the **Eraser** tool.
  - Zoom by pressing **Shift+Up arrow** or **Shift+Down arrow**
  - Pan the zoomed view with the arrow keys.

Figure 23: Left image: Creating a part shape region over the entire part. Right image: Using the eraser to exclude holes from the part shape region.

Draw a gripper clearance region

The gripper clearance regions define areas that must not be blocked. Located parts with something blocking the gripper clearance region, e.g., another part will be rejected. Collision checks in gripper clearance regions are used if **Reject colliding matches** is enabled, see Gripper clearance.

1. Click **Gripper clearance** to select the gripper clearance region layer. The gripper clearance region is blue.
2. Click **Auto** to automatically add a gripper clearance region surrounding the part shape, or use the **Brush** and **Eraser** tools to draw a gripper clearance region.

Draw a job exclusion region

In a job exclusion region, a defined part of this job is never reported as a result.

1. Click **Exclusion** to select the job exclusion region layer. The job exclusion region is gray.
2. Use the **Brush** and **Eraser** tools to draw a job exclusion region.

7.2.4.4 Adjust the pick position

There are different options on how to define and adjust the pick pose, see "Overview of the job configuration alternatives", page 47 for more information on what is applied for your PLOC2D system.

The part reference point tool

To adjust the pick position on the work plane's X or Y axis, or to rotate the pick position around the work plane's Z axis, use the part reference point tool.

1. Click **Part reference point** to start the part reference point tool.

✓ The part reference point is highlighted.

2. Drag the part reference point from its position at the origin to a position relative to the detected shape. It can, for example, be at the center of the shape or at a corner.
   - To position the part reference point with high accuracy, zoom in on the part.
   - To rotate the part reference point, use its rotation handle.
   - To reset the part reference point to the origin, click **Reset** at the upper left corner of the image.
   - To center the part reference point based on the edges of the detected shape, click **Center** at the upper left corner of the image.
     - If the shape is almost circular, the rotation is fixed when the part reference point is centered.
     - If the shape is elongated, the rotation is adapted so the x-axis is parallel to the longer side when the part reference point is centered.

✓ This position is now the reference position of the part. All pick positions defined by the robot are defined relative to this position.

7.2.4.5 Settings

Image acquisition

Each job uses one of four global exposure settings or a job-specific setting that controls the brightness and contrast.

Select an option (**Global setting 1 – 4** or **For this job only**) from the **Exposure settings** list in the **Advanced** section to change the exposure settings for the selected job. When new exposure settings have been selected, click **Acquire** to update the reference image.

Control the exposure settings

- To automatically set brightness and contrast, click **Auto adjust exposure**.
- To set brightness and contrast manually, adjust the **Brightness** and **Contrast** sliders.

✓ Exposure time and gain are shown above the **Brightness** slider.

Note that changes to these parameters are applied to all jobs that use the specified exposure setting (**Global setting 1 – 4**).

NOTE
We do not recommend to use job-specific settings if the system locates multiple jobs simultaneously. Image acquisition takes a longer time if every job has different image settings.

Algorithm

In the **Advanced** section, adjust the **Max rotation** and **Z-offset** parameters.

Setting	Description
Max rotation	Set tolerance for part rotation in relation to the reference position.
Z-offset	If the pick position is offset from the alignment plane, or if there are jobs with different part heights, set a Z-offset.

7.2.5 Run jobs

When the sensor is installed and configured, use this workflow step to confirm that the PLOC2D sensor system locates the parts of interest.

NOTE
Robot mounted sensor: Move the robot to the work plane robot pose for the selected job/jobs before running one of the locate commands.

1. In the user interface, go to the **Run** tab.
2. In the list in the **Settings** section, select which jobs to run:
   - Hover over a job to view the job details.
   - Click on a job to select or clear it.
   - Multiple jobs must be configured on the same work plane.
3. Collapse the list by clicking the arrow in the upper right corner, or somewhere outside the list.
4. Click **Locate** to acquire an image and search for the parts of interest.

✓ When the system has located the parts for all selected jobs, the results are added to the **Result log**.

If locate fails, see "Troubleshooting", page 69.

Click **Previous** and **Next** to display the result information for each located part. If the buttons are disabled, it means that no part or only one part has been located. Each result that is displayed is also added to the **Result log**.

Each result is represented in the image window by a shape contour and a blue circle. The circle represents the movement and rotation of the part relative to the reference part. See figure 24.

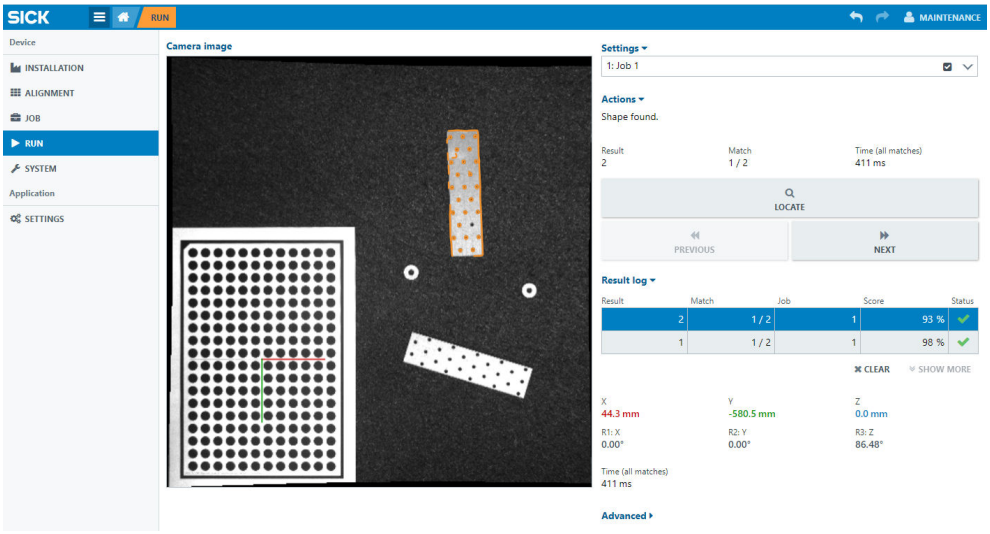


Figure 24: Result information for a located part

Result log

Results received either in the PLOC2D user interface or by the robot via the `Run.Locate` command are added to the **Result log**. The log stores information about the 20 most recent results. New results are added to the top of the list.

- Click on a row in the list to get the result information.
- Click **Clear** to clear the log.
- Click **Show more** or **Show less** to show all 20 results or the 5 latest results.

NOTE
The **Previous** and **Next** buttons are connected to the latest locate command and are used to browse the latest results.

Gripper clearance

To reject results where the gripper clearance region is blocked, enable **Reject colliding matches**.

For a colliding match, the **Camera image** view shows the gripper clearance region as transparent red and the colliding edges as opaque red.

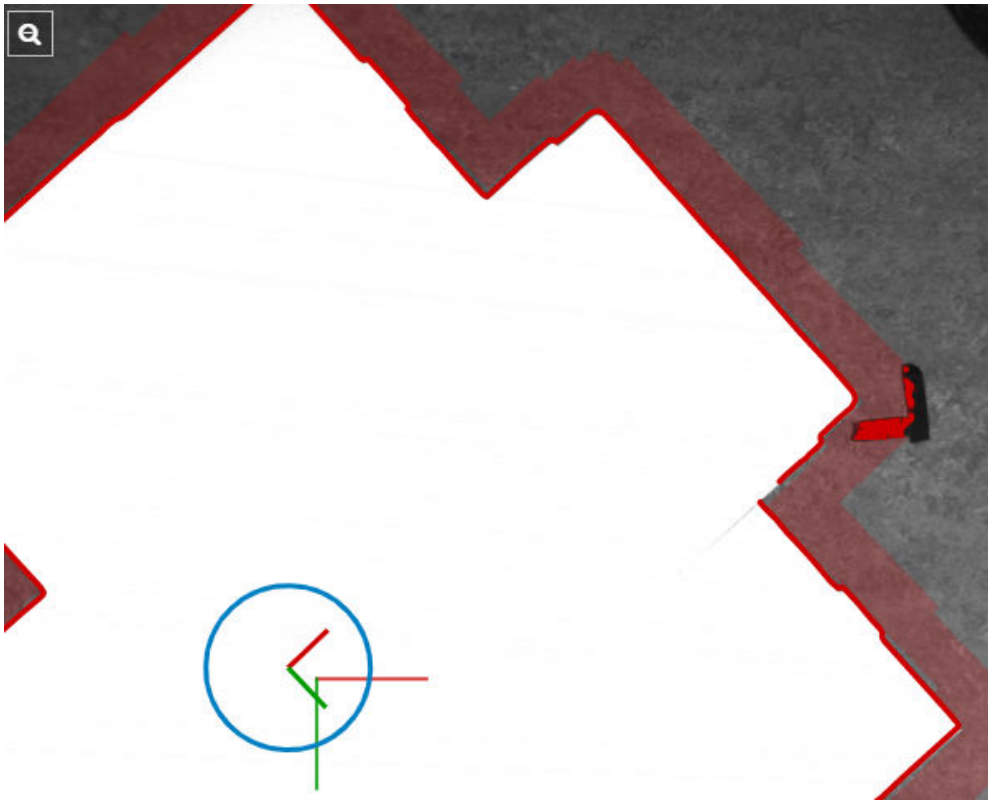


Figure 25: A colliding match

Exclusion regions

Both work plane exclusion regions and job exclusion regions are shown with a grey overlay in the camera image view. The overlay is red if a part is located partially in an exclusion region.

To accept results partially in an exclusion region, disable **Reject matches on image border**. User level **Service** required.

Result sorting

By default results are sorted by score. For applications where the parts are aligned in an ordered structure and the order of results are important, select **Lanes** in the **Order** list.

To change the **Result sorting** or adjust the settings a successful locate of the job is required. The settings apply to all jobs using the work plane referenced in the **Result sorting** heading.

The lane positions are automatically adjusted to the first found part. All parts found in a specific lane are then sorted within the lane in the sorting direction.

To adjust the width and rotation of lanes, drag the **Lane width** and **Lane angle** sliders or use the lane tool in the image view.

To use the lane tool

- Click  .

✓ The lane tool controls are visible in the image view.

To adjust the width of lanes

- Move the pointer to a lane border. When the pointer becomes a  , drag the pointer to adjust the lane widths.

To adjust the rotation of lanes

- Move the pointer over the lanes. When the pointer becomes a  , drag the pointer to rotate the lanes.

To change the lane order

- Click the lane order buttons to change the lane order.
- Click  to order lanes from left to right and report results within lanes from top to bottom.
- Click  to order lanes from left to right and report results within lanes from bottom to top.
- Click  to order lanes from right to left and report results within lanes from top to bottom.
- Click  to order lanes from right to left and report results within lanes from bottom to top.
- Click  to order lanes from top to bottom and report results within lanes from right to left.
- Click  to order lanes from top to bottom and report results within lanes from left to right.
- Click  to order lanes from bottom to top and report results within lanes from left to right.
- Click  to order lanes from bottom to top and report results within lanes from right to left.
- Click  to zoom out.
- Click an arrow in a lane to change the order in that specific lane.

7.2.6 System settings

Use the **System** tab to adjust system settings and monitor the system log.

7.2.6.1 Identification

This section contains identification information about the device e.g., **Version** and **Camera serial number**. We recommend that you give the device a unique name in the **Device name** field.

7.2.6.2 Network settings

NOTE
To identify the IP address of the PLOC2D system, download and run PLxManager, see "PLxManager", page 70. The **Available devices** section displays the IP addresses for all devices on the network. It is possible to change the IP address of a device by right-clicking the device, and then **Edit IP address**.

Device IP configuration

Configure the IP settings for the RG system in this section:

- If the IP address comes from a DHCP server on your network, select **Obtain an IP address automatically**.
- Otherwise, select **Use the following IP address** and enter a static IP address in the **IP Address** and **Subnet mask** fields.

Make sure that the network communication settings are correctly set up:

- The RG system must be on the same network as the robot or computer it is communicating with.
- The RG system must not use the same IP address as the robot or computer it is communicating with.

Restart the RG system to activate the changed network settings.

Remote FTP server

To set up an FTP server

- Enter the IP address, port, username, and password of the FTP server.
- Click **Test Connection** to test the FTP server settings.

The RG system can be set up to automatically export part localization results to an FTP server.

- Select conditions for when to export part localization results in the **Automatic FTP export of part localization data** list.
- The default setting is to not automatically export part localization data (**Off**).

Device FTP server

Enable the communication interface of the FPT server in the device. By default, the **Enable FTP server in device** setting is disabled.

This setting should be disabled, if not instructed otherwise by a SICK representative.

Remote NTP server

There are two ways to set the timestamp for log entries.

- By default, the system log timestamps are based on how much time has passed since the sensor started.
- The sensor can also synchronize with a time server, using network time protocol (NTP), to use UTC time for system log timestamps.

To use UTC time

1. Click the toggle to enable **Set time automatically**.
2. Enter **Network Time server IP address** and **Port**.

To see the current system time

- Click **Show device time.**

7.2.6.3 Robot communication

In this section, set the mounting type, rotation convention, and protocol that the robot uses for communication with the robot guidance (RG) system.

By default, the RG system uses the same port for incoming and outgoing messages.

Mounting type

Select mounting type from the list. The mounting types are explained in the list.

Only the jobs defined with work planes that were aligned using the selected mounting type method can be used.

Rotation convention

Select a rotation convention from the list. The rotation conventions are explained in the list.

Rotation results in the **Alignment** and **Run** pages, and in the fieldbus monitor will be converted to a new rotation convention.

Native protocol

The native protocol is the recommended protocol. It allows access to all commands that are available in the RG system. This protocol also automatically identifies the syntax that the robot controller uses. If it is not possible for the RG system to clearly identify the syntax (for example if the robot controller sends a command that is applicable to more than one syntaxes) you can select a syntax in the **Syntax** list.

- In the **Native protocol** section, enable the communication interface. By default, the **Enable native protocol communication interface** setting is disabled.
- Enter the port number in the **Port** field. 14158 is the default port.
- See the **Syntax** list for examples of commands formatted in a specific syntax.
- Some robot brands require messages to and from the robot controller to be separated in specific ways. See the **Message framing** list for options on how to separate messages to the robot controller.

Compatibility protocol

Compatibility protocol is used when a customer-specific protocol has been implemented.

- In the **Compatibility protocol** section, enable the communication interface. By default, the **Enable compatibility protocol communication interface** setting is disabled.
- Enter the port number in the **Port** field. Default port number is 6008.
- See the **Message framing** list for options on how to separate messages to the robot controller.

Fieldbus configuration

Click a protocol in the **Protocol type** list, to activate a fieldbus communication protocol.

When you activate a protocol type, the data stream is displayed in the fieldbus monitor in the **Diagnostics** section.

Select a version in the **Protocol version** list:

- **Version 2: Using telegram ID (recommended):** Default for new installations.
- **Version 1: Using control bits:** Select this option for existing installations using command control bits.

For implementation details of the fieldbus protocol, see "PROFINET and EtherNet/IP communication specification", page 77.

Select a byte order in the **Byte order** list:

- **Little-endian: Least significant byte first**
- **Big-endian: Most significant byte first**

A description of the options is shown when they are selected.

7.2.6.4 Illumination settings

The robot guidance system can be configured to use either internal or external illumination, or a combination of both. The illumination configuration is applied system wide.

For information about connecting external illumination, see "External illumination", page 36.

The PLOC2D types PLOC2D-611-6RB/12RB have an internal (integrated) illumination option to enable or disable individual lights, see figure 26, page 56. Mark the lights that are to be enabled when running the system.

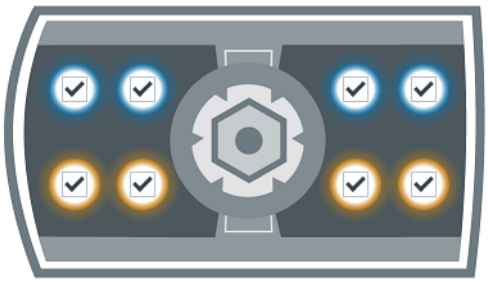


Figure 26: InspectorP611 internal illumination settings

7.2.6.5 Diagnostics

The fieldbus monitor is found in the **Diagnostics** section.

For implementation details of the fieldbus protocol, see "PROFINET and EtherNet/IP communication specification", page 77.

Fieldbus monitoring

This applies when the default **Protocol version**, "Using telegram ID", is selected in "Fieldbus configuration", page 55.

- The left part of the monitor represents the commands sent to the device.
- The right part of the monitor represents the results sent from the device.
- The two 64-byte registers represent data fields.
- Mouse over the registers to see the parameter used for that specific bit or byte.
- Runtime and system status, i.e. result data bytes 12 and 13, are visualized in the right-most area.

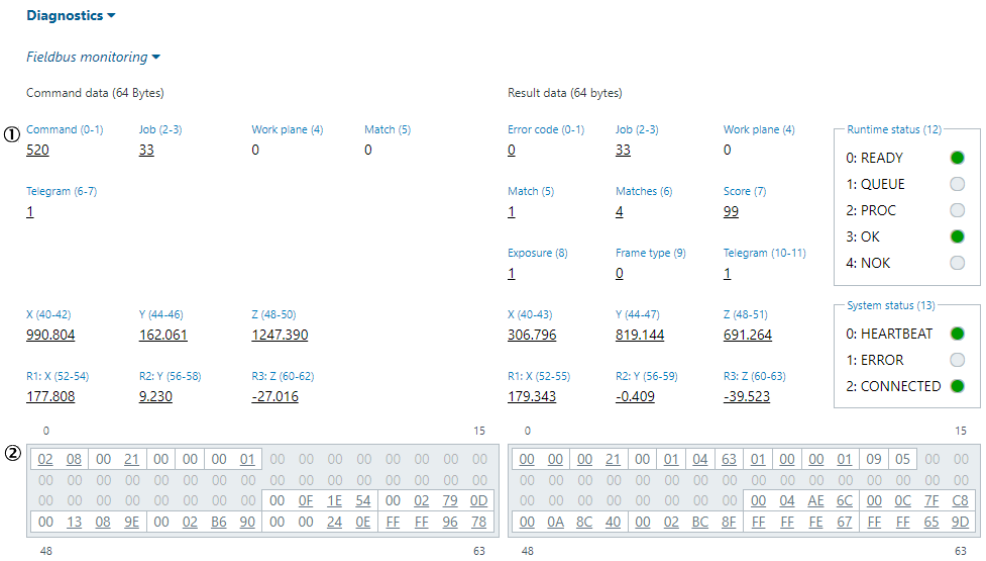


Figure 27: Fieldbus monitor using telegram ID

① Data fields

② 64-byte registers

Fieldbus monitoring using control bits

This applies when the **Protocol version** "Using control bits" is selected in "Fieldbus configuration", page 55.

- The left part of the monitor represents the commands sent to the device.
- The right part of the monitor represents the results sent from the device.
- The two 16-bit registers represent control bits.
- The control lights next to the control names are visualizations of the control bits.
- The two 64-byte registers represent data fields.
- The data fields are interpreted and presented between the registers.
- Mouse over the registers to see the parameter used for that specific bit or byte.

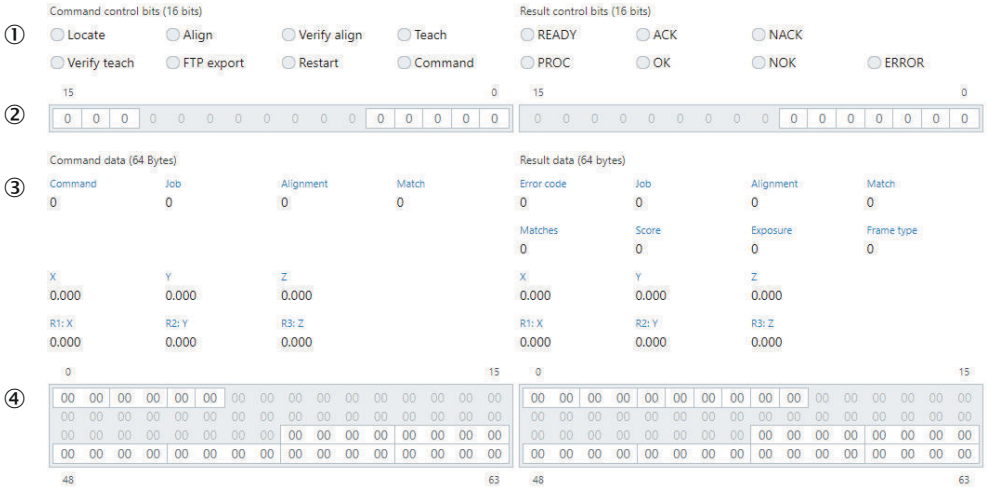


Figure 28: Fieldbus monitor using control bits

① Control lights

② 16-bit registers

③ Data fields

④ 64-byte registers

System log

The system log contains device event descriptions with corresponding timestamps. The system log can be filtered using a case sensitive text filter that supports negation via the ! operator.

The system log is cleared each time the sensor is re-started. Click **Clear** to clear all items manually, or click **Save to file** to save the current system log to a file.

7.2.6.6 Maintenance

Restart and reboot

There are multiple ways to restart the RG system:

- Click the restart button that is found in the **Maintenance** section in the user interface.

Figure 29: Restart button in user interface

- Send the robot interface command `System.Restart.Software`.
- Press and hold the Enter button found on the top of the physical device.

Figure 30: Enter button on device

  - Press and hold for 3 seconds to restart the software on the device.
  - Press and hold for 10 seconds to reboot the device.

7.3 Robot system workflow

7.3.1 Part localization

During a part localization cycle, the robot controller communicates with the PLOC2D sensor by the `Run.Locate` command. The `Run.Locate` command acquires a new image and performs a localization of the parts in the specified jobs. The command accepts two optional parameters:

- `job`: The ID of the job in string form or an array of jobs separated by space, e.g. '1' or '1 3 8 12'. If this parameter is omitted, all configured jobs will be located.
- `match`: The ID of the match to return from a previous `Run.Locate` command. If this parameter is omitted, the operation will always trigger a new image and return the first result.

NOTE

The `match` parameter can only be used to get additional localization results from the same image as a previous `Run.Locate` command without the `match` parameter.

NOTE

Performing `Run.Locate` on all jobs may be slow since the jobs are located in sequence.

NOTE
The command `Run.LocateAll` can be used to get all located results at once, instead of getting one result at a time.

The results for a job are sorted by X-position followed by Y-position, with regard to the alignment target.

For a full list of commands and associated parameters, see "", page 60.

Conveyor tracking

The image exposures for each `Run.Locate` command can be registered using conveyor tracking. Connect the robot controller to pin 16 on the **Power and I/O** connector on the PLOC2D sensor to activate conveyor tracking. For more information, see "Conveyor tracking", page 36.

7.3.2 Coordinate representation

Rotation is by default represented as extrinsic X-Y-Z Euler angles, it is possible to change the rotation representation to better fit your robot brand, see "Rotation convention", page 55.

NOTE
Please consult your robot manual for information about the coordinate representation used by your robot brand. You may need to convert the coordinates reported by the robot guidance system to a representation valid for your application.

7.3.3 Robot program

See the flowchart diagram in figure 31 for a step by step description of how a PLOC2D sensor and a robot interacts during a part localization cycle. Robot programs for different types of robots are available for download via the **SICK Support Portal**.

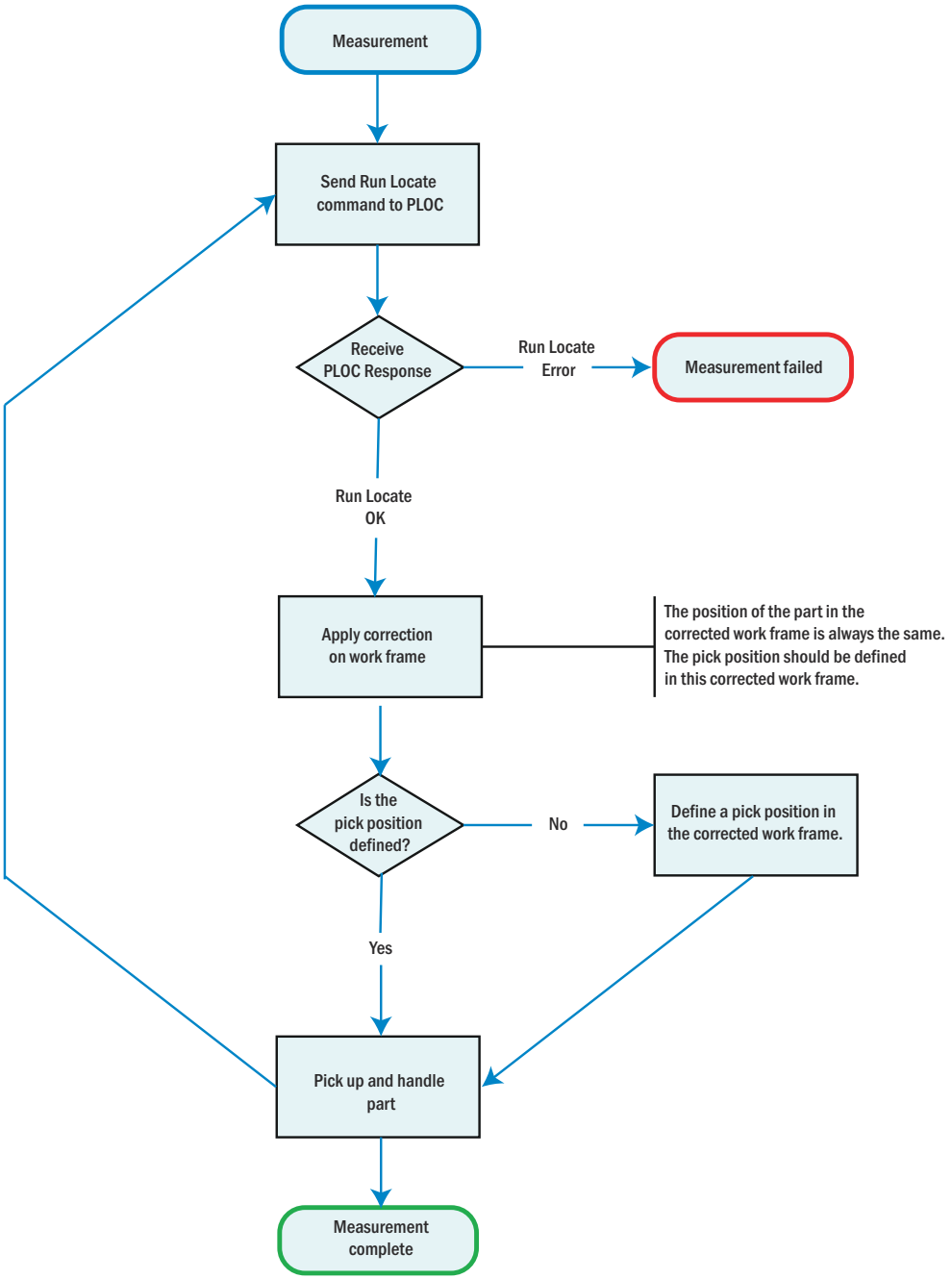


Figure 31: Robot operation flowchart

NOTE
Correctly typed PLOC2D robot commands always yields a response message (Ok/Error).

Commands

PLOC2D accepts the commands in the following table, see table 2, page 60. All parameters are explained in table 5.

Table 2: PLOC2D commands

Command	Description
`Alignment.Align,alignment`	Acquire a new image and align sensor to work plane alignment target.

Command	Description
`Alignment.Align, alignment,x,y,z,r1,r2,r3`	Acquire a new image and align sensor to work plane alignment target using robot position. Robot coordinates should only be used if the sensor is mounted to the robot arm.
`Alignment.HandEye.Pose.Add ,x,y,z, r1,r2,r3,pose`	Acquire a new image and collect information on sensor position in relation to alignment target and robot. Up to 32 poses can be collected. This command is only used if the sensor is mounted to the robot arm.
`Alignment.HandEye.Calculat e`	Calculate how the sensor is mounted to the robot arm. At least three poses are needed. This command is only used if the sensor is mounted to the robot arm.
`Alignment.LocateTarget,ali gnment`	Acquire a new image and locate the work plane alignment target.
`Alignment.Verify,alignment`	Acquire a new image and compare the located target position with the original alignment. The alignment verification threshold parameter is used to determine if the difference is acceptable.
`Job.Export,job,destination`	Export a job to an FTP server. Only one job at a time can be exported. The parameter `destination` specifies the location on the FTP server as a relative path to the FTP server home folder. The destination folder is created as a sub-folder in the FTP server's home folder.
`Job.Import,job,source`	Import a job from an FTP server. Only one job at a time can be imported. The parameter `job` specifies what job ID the imported job will use. The parameter `source` specifies the name of the job folder on the FTP server as a relative path to the FTP server home folder.
`Job.PartReferencePoint.Set ,job,x,y,z,r1,r2,r3`	Change the part reference point to the current robot gripper tool center point. This command is only used if the sensor is mounted to the robot arm.
`Run.Locate,job`	Acquire a new image and attempt to locate the parts from the specified job. More than one job can be specified. If no job is specified, the command locates all configured jobs and returns the first result.
`Run.Locate,job,match`	Return a result from the previous `Run.Locate` command. The result to return is specified by the `match` parameter. No new image is acquired when using the `Run.Locate` command with the `match` parameter.
`Run.LocateAll,job`	Acquire a new image and attempt to locate the parts from the specified job. More than one job can be specified. If no job is specified, the command locates all configured jobs. All results from all used jobs are returned as a comma-separated list.

Command	Description
`System.Ftp.Export,source,destination`	Export specified files to an FTP server. The parameter `source` specifies the files to export. E.g., `run/images/*` specifies the captured images from the latest `Run.Locate` command. The parameter `destination` specifies the location on the FTP server as a relative path to the FTP server home folder. The destination folder is created as a sub-folder in the FTP server's home folder.
`System.Restart.Software,reason`	Initiates a software restart with a text message string for logging.

The commands must be formatted in one of the following formats:

- CSV
- Fixed
- JSON
- XML

Examples

See table 3 for CSV and XML command examples. Other syntax examples, e.g. commands in JSON, are available when selecting syntax in the PLOC2D user interface.

Table 3: PLOC2D command examples

Command	Examples
`Aligment.Align,alignment`	**CSV:** `Alignment.Align,1`
	XML: `<message><name>Alignment.Align</name><alignment>1</alignment></message>`
`Alignment.Align,alignment,x,y,z,r1,r2,r3`	**CSV:** `Alignment.Align,1,1220.31,38.132,590.814,179.163,0.695,-178.974`
	XML: `<message><name>Alignment.Align</name><alignment>1</alignment><x>1220.31</x><y>38.132</y><z>590.814</z><r1>179.163</r1><r2>0.695</r2><r3>-178.974</r3></message>`
`Alignment.HandEye.Pose.Add,x,y,z,r1,r2,r3,pose`	**CSV:** `Alignment.HandEye.Pose.Add,101.2,52.34,63.23,0.22,0.45,90.11,?`
	XML: `<message><name>Alignment.HandEye.Pose.Add</name><x>101.2</x><y>52.34</y><z>63.23</z><r1>0.22</r1><r2>0.45</r2><r3>90.11</r3><pose>?</pose></message>`
`Alignment.HandEye.Calculate`	**CSV:** `Alignment.HandEye.Calculate`
	XML: `<message><name>Alignment.HandEye.Calculate</name></message>`
`Alignment.LocateTarget,alignment`	**CSV:** `Alignment.LocateTarget,1`
	XML: `<message><name>Alignment.LocateTarget</name><alignment>1</alignment></message>`
`Alignment.Verify,alignment`	**CSV:** `Alignment.Verify,1`
	XML: `<message><name>Alignment.Verify</name><alignment>1</alignment></message>`

Command	Examples
Job.Export,job,destination	**CSV:** Job.Export,1,jobs/1
	XML: <message><name>Job.Export</name><job>1</job><destination>jobs/1</destination></message>
Job.Import,job,source	**CSV:** Job.Import,1,jobs/1
	XML: <message><name>Job.Import</name><job>1</job><source>jobs/1</source></message>
Job.PartReferencePoint.Set,job, x,y,z,r1,r2,r3	**CSV:** Job.PartReferencePoint.Set,1,327.846,797.271,692.477, -0.091,-1.084,42.272
	XML: <message><name>Job.PartReferencePoint.Set</name><job>1</job>name><x>327.846</x><y>797.271</y><z>692.477</z><r1>-0.091</r1><r2>-1.084</r2><r3>42.272</r3></message>
Run.Locate,job	**CSV 1:** Run.Locate,1
	XML 1: <message><name>Run.Locate</name><job>1</job></message>
	CSV 2: Run.Locate,2 3
	XML 2: <message><name>Run.Locate</name><job>2 3</job></message>
Run.LocateAll,job	**CSV 1:** Run.LocateAll,1
	XML 1: <message><name>Run.LocateAll</name><job>1</job></message>
	CSV 2: Run.LocateAll,2 3
	XML 2: <message><name>Run.LocateAll</name><job>2 3</job></message>
	CSV 3: Run.LocateAll
	XML 3: <message><name>Run.LocateAll</name><job></job></message>
Run.Locate,job,match	**CSV:** Run.Locate,3,2
	XML: <message><name>Run.Locate</name><job>3</job><match>2</match></message>
System.Ftp.Export,source,destination	**CSV:** System.Ftp.Export, run/images/*, latest_located
	XML: <message><name>System.Ftp.Export</name><source>run/images/*</source><destination>latest_located</destination></message>
System.Restart.Software,reason	**CSV:** System.Restart.Software,Initiated by robot program
	XML: <message><name>System.Restart.Software</name><reason>Initiated by robot program</reason></message>

Responses

See table 4 for CSV command responses.

Table 4: PLOC2D command responses

Command	Response
Alignment.Align,alignment	Alignment.Align.Ok,alignment,x,y,z,r1,r2,r3
	Alignment.Align.Error,alignment,error
Alignment.HandEye.Pose.Add,x,y,z,r1,r2,r3,pose,count	Alignment.HandEye.Pose.Add.Ok,pose,count
	Alignment.HandEye.Pose.Add.Error,pose,error
Alignment.HandEye.Calculate	Alignment.HandEye.Calculate.Ok,x,y,z,r1,r2,r3,error,time
	Alignment.HandEye.Calculate.Error,error
Alignment.LocateTarget,alignment	Alignment.LocateTarget.Ok,alignment,x,y,z,r1,r2,r3
	Alignment.LocateTarget.Error,alignment,error
Alignment.Verify,alignment	Alignment.Verify.Ok,alignment
	Alignment.Verify.Error,alignment,error
Job.Export,job,destination	Job.Export.OK,job,destination
	Job.Export.Error,job,destination,error
Job.Import,job,source	Job.Import.OK,job,source
	Job.Import.Error,job,source,error
Job.PartReferencePoint.Set,job,x,y,z,r1,r2,r3	Job.PartReferencePoint.Set.Ok,job
	Job.PartReferencePoint.Set.Error,job,error
Run.Locate,job	Run.Locate.Ok,job,match,matches,x,y,z,r1,r2,r3,scale,score,time,exposure,identified
	Run.Locate.Error,job,score,time,error
Run.LocateAll,job	Run.LocateAll.Ok,matches,results
	Run.LocateAll.Error,job,score,time,error
System.Ftp.Export,source,destination	System.Ftp.Export.Ok,source,destination
	System.Ftp.Export.Error,source,destination,error
System.Restart.Software,reason	System.Restart.Software.Ok
	System.Restart.Software.Error,error

Parameters

Table 5: PLOC2D parameters

Parameter(s)	Description
alignment	The number of the current work plane.
count	The total number of poses used for calculating the sensor position on the robot arm.
destination	Specifies the folder name where exported files are saved on the FTP server.

Parameter(s)	Description
`error`	For most responses this is the error code returned by the PLOC2D sensor: 9000 = Invalid parameter. At least one input parameter is invalid. 9100 = The image acquisition failed. 9101 = The image could not be stored on the SD-card. 9200 = No valid image found. 9201 = PLOC2D sensor not calibrated. 9202 = PLOC2D sensor not aligned. 9203 = Job not valid. 9301 = Calibration target not found. 9400 = Alignment failed. 9401 = Alignment target not found. 9402 = Verify alignment failed. 9600 = Locate failed. 9601 = Locate failed. Score too low. 9603 = Locate failed. Requested match not found. 9604 = Locate failed. Multiple work planes. 9607 = Locate failed. Gripper clearance collision. 9810 = File not found. The source file could not be opened for reading. 9820 = Connection to remote server failed. 9995 = Number of locate attempts exceeded in demonstration mode. 9996 = Unsupported operation. 9997 = Operation timed out. 9999 = An unknown error occurred. For some PLOC2D responses, this parameter name also means reprojection error value (in pixels).
`exposure`	The conveyor tracking index indicating the image capture order. Applicable when locating multiple jobs with different exposure settings.
`identified`	A space-separated list of identified job IDs. Used for the `Run.Locate` response.
`job`	A space-separated list of job IDs. Can be a single job ID. All jobs must be defined using the same work plane.
`match`	The index of the current match.
`matches`	The number of matches found.
`pose`	The slot index of the pose used for calculating the sensor position on the robot arm. Up to 32 poses can be used. The character "?" can be used to get the next available slot instead of keeping track of used pose slots.
`reason`	An optional text string that will be visible in the system log.
`results`	A comma-separated list of results, where each result consists of `match,job,x,y,z,r1,r2,r3,scale,score,exposure`.
`scale`	Size of the current part compared to the reference part. If scale > 1, it means that the current part is closer to the sensor than the reference part.
`score`	Score value (%) for the current result. See "Job configuration", page 47 for details.
`source`	Specifies the files to export from the SD card when using the `System.Ftp.Export` command. Specifies the job folder name on the FTP server, when using the `Job.Import` command.
`time`	Part localization time.

Parameter(s)	Description
`x,y,z,` `r1,r2,r3`	Parameters `x,y,z` are distances in millimeters, `r1,r2,r3` are rotations in degrees. In commands using a robot mounted sensor: The robot tool center point position expressed in a robot base. In `Alignment.Align` or `Alignment.LocateTarget` responses: The alignment target position relative to the sensor. Note that the `x,y,z,r1,r2,r3` results are for information only, and are not used in the robot program. In `Run.Locate` responses using a stationary sensor: The located part position relative to the reference part, expressed in the work plane base defined with the alignment target. This result is used as a correction to the original pick pose in the robot program. In `Run.Locate` and `Alignment.HandEye.Calculate` responses using a robot mounted sensor: An absolute position of the part or alignment target, expressed in the same robot base as was used in the command.

8 Maintenance

8.1 Maintenance plan

The product requires the following maintenance work at regular intervals:

Table 6: Maintenance schedule

Interval	Maintenance work	To be carried out by
Cleaning interval depends on ambient conditions and climate	Clean housing and front screen	Specialist
Every 6 months	Check the screw connections and plug connections	Specialist

8.2 Cleaning the device

At regular intervals, check the inspection window and the housing of the device for contamination (see "Maintenance plan", page 67). This is especially relevant in harsh operating environments (dust, abrasion, dampness, fingerprints, etc.).

The inspection window must be kept clean and dry during operation.

NOTE
Exercise caution when cleaning the device. If the device position is changed during cleaning, the work planes must be re-aligned.

NOTICE
Device damage due to improper cleaning!
Improper cleaning may result in damage to the device.

- Only use suitable cleaning agents.
- Never use sharp objects for cleaning.

Cleaning the inspection window

NOTICE
Damage to the inspection window!
Reduced analysis performance due to scratches or streaks on the inspection window!

- ► Only clean the inspection window when wet.
- ► Use a mild cleaning agent that does not contain powder additives. Do not use aggressive cleaning agents, such as acetone, etc.
- ► Avoid any movements that could cause scratches or abrasions on the inspection window.
- ► Only use cleaning agents suitable for the screen material (2 mm glass with scratch-proof coating).

NOTE
Static charge may cause dust particles to stick to the inspection window. This effect can be avoided by using an anti-static cleaning agent in combination with the SICK lens cloth (can be obtained from www.sick.com).

NOTE
If the inspection window is scratched or damaged (cracked or broken), the window must be replaced. Contact SICK Service to arrange this.

Cleaning procedure

CAUTION
Laser and LED safety
See "Operational safety and particular hazards", page 9 for information regarding laser and LED safety.

- ► Switch off the device for the duration of the cleaning operation. If this is not possible, use suitable laser protection goggles. These must absorb radiation of the device's wavelength effectively.
- ► Plastic window: Clean the inspection window only with a clean, damp, lint-free cloth, and a mild anti-static lens cleaning fluid.

Cleaning the housing

To ensure that heat is adequately dissipated from the device, the housing surface must be kept clean.

- ► Clear the build-up of dust on the housing with a soft brush.

8.3 Back up and restore

Use the PLxManager tool to create a backup of a device and to restore a backup.

Please see "PLxManager", page 70 on how to download PLxManager and find instructions on how to create a backup and restore PLOC2D.

9 Troubleshooting

9.1 Functional

Connection/IP

If there are connection issues with the PLOC2D device, check the following:

- Is the ethernet cable connected?
- Is the PLOC2D and the computer on the same network?
- Is there an IP address conflict between the PLOC2D and the computer?

Power supply

If the PLOC2D device LED:s are not lit, check the following:

- Is the power supply connected?
- Is the power supply the correct specification?

9.2 Operational

Not finding target

If the calibration or alignment target cannot be found, check the following:

- Is the target selected in the UI the same as the target used?

Locate failure

If the PLOC2D fails to locate the object, check the following:

- Is the score threshold too high?
- Is the maximum rotation to low?
- Is the reference image correct?

Low accuracy

If the PLOC2D performs with lower than normal accuracy, check the following:

- Is calibration adequate?
- Is the robot work plane defined accurately?
- Has the gripper position been altered?
- Has the sensor position been altered?
- Is the gripper tool center part definition correct?

Erratic measurements

If the PLOC2D displays erratic measurements, check the following:

- Is the job successfully configured?
- Is the maximum allowed rotation too high?

9.3 Customer service

If you require any technical information, our customer service department will be happy to help. Create a support ticket (see PLxManager), or find contact information to your representative on the final page of this document.

NOTE
Before contact, make a note of all type label data such as type code, serial number, etc. to ensure faster processing.

PLxManager

In the PLxManager tool you can find features and instructions on how to create a support ticket, create a backup and restore a backup of the device, and how to replace a device.

Get started with PLxManager

1. Go to supportportal.sick.com and log in.
   - You must register a user account to access SICK Support Portal.
2. Go to the Downloads section by the menu options: Systems/Robot Guidance/PLOC/Downloads
3. Download and open the latest version of PLxManager.
4. Click on the **More options** button in the top right corner, see figure 32.
5. Choose the desired instruction in the menu option **How to...**.

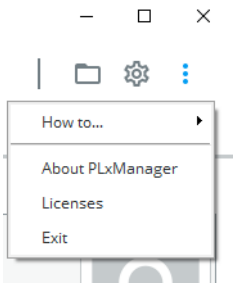


Figure 32: PLxManager user interface menu

9.4 Replace device

NOTE

We recommend to re-align the PLOC2D workplanes when replacing the sensor, or if the mounting position of the PLOC2D changes. See "Hand-eye alignment", page 42.

Use the PLxManager tool when replacing a device.

Please see "PLxManager", page 70 on how to download PLxManager and find instructions on how to replace a device.

9.5 Repairs

Repairs on the product may only be carried out by the manufacturer. Any interruption or modification of the product will invalidate the manufacturer warranty.

9.6 Disposal

CAUTION

Risk of injury due to hot device surface!

The surface of the device can become hot during operation.

► Before commencing disassembly, switch off the device and allow it to cool down as necessary.

Any device which can no longer be used at the end of the product life cycle must be disposed of in an environmentally friendly manner in accordance with the respective applicable country-specific waste disposal regulations. As they are categorized as electronic waste, the device must never be disposed of with household waste.

ATTENTION

Danger to the environment due to improper disposal of the product!

Disposing of the product improperly may cause damage to the environment.

Therefore, take note of the following information:

- ► Always observe the valid regulations on environmental protection.
- ► Following correct disassembly, pass on any disassembled components for reuse.
- ► Separate the recyclable materials by type and place them in recycling containers.

10 Technical data

10.1 Optics and Illumination

Type	PLOC2D	
Focus	**PLOC2D-2000:** Fixed focus and aperture on the lens. **InspectorP65x:** Manual adjustment of the focus and aperture on the optional lens unit. **InspectorP63x:** Compact C-mount lenses: Fixed aperture, manual sharpness setting on the lens. C-mount lenses: Manual sharpness and aperture setting on the lens. S-mount lenses: Fixed aperture, working distances can be implemented using distance ring, manual sharpness setting using focus screw. **InspectorP62x:** Electric adjustment of the focus on the lens. **InspectorP611:** Manual adjustment of the focus on the lens (with the included tool)	
Illumination for field of view	Optional e.g., variants of the VI83I integrable illumination unit: 11 x LED, visible light. White (λ = 6,000 ± 500 K) Blue (λ = 455 ± 20 nm) Red (λ = 620 ± 30 nm).	
	InspectorP62x	4 LEDs (2 on the left, 2 on the right) Light color combination, type-dependent: Visible red light (λ = 617 nm ± 15 nm) Visible blue light (λ = 470 nm ± 15 nm) Infrared light (λ = 850 nm ± 25 nm)
	InspectorP611	8 LEDs (4 amber, 4 blue) Light color combination, optional: Visible amber light (λ = 617 nm ± 50 nm) Visible blue light (λ = 470 nm ± 15 nm)
Feedback LED (spot in field of view)	InspectorP62x/611 or optional e.g., variants of the VI83I integrable illumination unit: 1 x LED, visible green light (λ = 525 ± 15 nm).	
LED risk group of illumination unit	Risk group 1 (low risk) according to IEC 62471-1: 2006-07/EN 62471-1: 2008-09.	
	“Blue - Narrow + Feedback LED” option (PLOC2D-2000) • Risk group 2 (moderate risk) according to IEC 62471-1: 2006-07/EN 62471-1: 2008-09 due to exposure to blue light.	
Aiming laser (field of view)	Visible light. Red (λ = 630 nm ... 680 nm), can be disengaged **InspectorP611:** Visible light. Red (λ = 630 nm ± 15 nm), can be disengaged	
Laser class	1, complies with 21 CFR 1040.10 except for the tolerance according to “Laser Notice No. 50” from June 24, 2007 (IEC 60825-1:2014, EN60825-1:2014).	

10.2 Performance

Type	PLOC2D
Working distance	See "Field of view diagrams", page 16
Image sensor resolution	**InspectorP65x:** 4.2 MP **InspectorP63x:** 1.3 MP (InspectorP631), 1.9 MP (InspectorP632) **InspectorP62x:** 1.3 MP **InspectorP611:** 1.2 MP

Type	PLOC2D
Image sensor type	**InspectorP65x/62x/611:** CMOS matrix sensor, gray scale **InspectorP63x:** Monochrome
Image memory	MicroSD memory card. **InspectorP611:** Internal memory

10.3 Interfaces

Type	PLOC2D
Ethernet	TCP/IP Function: EtherNet/IP, UDP, PROFINET Data transmission rate: • **InspectorP65x + P63x:** 10 Mbit/s ... 1,000 Mbit/s • **InspectorP62x/611:** 10 Mbit/s ... 100 Mbit/s Protocol: FTP, HTTP
Operator interfaces	Web server

10.4 Mechanics and electronics

Type	PLOC2D
Optical indicators	**InspectorP65x:** 10 x RGB status LEDs, 10 x bar graph, 1 x green feedback spot **InspectorP63x:** 5 x RGB LEDs: status indicators, 1 x LED: feedback LED, green, 5 x RGB LEDs: bar graph, blue **InspectorP62x:** 5 x status LEDs, 10 x LED bar graphs, 1 x green feedback spot **InspectorP611:** 6 x status LEDs, 8 x illumination LEDs, 1 x green feedback spot
Acoustic indicators	1 x beeper for signaling events, can be deactivated
Supply voltage	24 V DC ± 20% **InspectorP62x:** 12 V DC ... 24 V DC, ± 20 % **InspectorP611:** 12 V DC ... 24 V DC, ± 15 %
Current consumption	**InspectorP65x:** Max. 2.0 A (with switching outputs) **InspectorP63x:** Max. 1.5 A (with switching outputs)
Power consumption	**InspectorP65x:** Typically 20 W (for switching outputs without load) **InspectorP63x:** 10 W (for switching outputs without load) **InspectorP62x:** Typically 4 W **InspectorP611:** Typically 3.5 W
Weight	**InspectorP65x:** 635 g excluding optics **InspectorP63x:** 430 g excluding optics **InspectorP62x:** 170 g **InspectorP611:** 165 g
Material Housing	Aluminum die cast **InspectorP611:** Zinc die cast
Material Viewing window	Glass or plastic (PMMA), 2 mm thick, with scratch-proof coating.
Electrical protection class	III, in accordance with DIN EN 60950-1: 2014-08
Enclosure rating	**InspectorP65x + P62x:** IP65 **InspectorP63x:** IP67 **InspectorP611:** IP54

10.5 Ambient data

Type	PLOC2D	
Vibration resistance	In accordance with EN 60068-2-6: 2008-02	
Shock resistance	In accordance with EN 60068-2-27: 2009-05	
Ambient temperature	Operation[1)]	0 °C ... +50 °C **InspectorP611**: 0 °C ... +40 °C
	Storage	–20 °C ... +70 °C
Permissible relative humidity	0% ... 90%, non-condensing	

1) Notes regarding adequate dissipation of lost heat: see "Mounting requirements", page 25

11 Accessories

11.1 General

All accessories for the product can be found at www.sick.com/PLOC2D.

11.2 Lens types

The following lens types are available for PLOC2D:

PLOC2D variants	Lens types and f-numbers
Variants with C-mount lens	6 mm (f1.4–16), 8 mm (f1.4–16), 12 mm (f1.4–16), 15 mm (f1.4–16), 25 mm (f1.4–16), 35 mm (f1.4–16), 50 mm (f1.4–16)
Variants with S-mount lens	9.6 mm (f8), 12.5 mm (f8), 17.5 mm (f8), 25 mm (f8)

11.3 Illumination

Illumination

The following types of illumination are available for PLOC2D:

PLOC2D variants	Illumination types
Variants with an InspectorP65x sensor	Red/Amber, White, Blue
Variants with an InspectorP63x sensor	White wide, White medium, White narrow, Blue wide, Blue medium, Blue narrow
Variants with an InspectorP62x sensor	Infrared, Red/Blue

12 Appendix

12.1 Licenses

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12.2 PROFINET and EtherNet/IP communication specification

This chapter defines the layout for data transmitted over PROFINET and EtherNet/IP.

A GSDML file for PROFINET and an EDS file for EtherNet/IP file is available from supportportal.sick.com

Conventions and definitions

- By default, **Protocol version** is using telegram ID. Control bits can be enabled for legacy installations, see "Fieldbus configuration", page 55.
- By default, integers use big-endian byte ordering, see "Fieldbus configuration", page 55.
- Distances are measured in millimeters but typically represented using signed integers where each integer step means one thousand of a millimeter (e.g. 12345 = 12.345 mm).
- Rotations are measured in degrees but typically represented using signed integers where each integer step means one thousand of a degree (e.g. -54321 = -54.321 degrees).

12.2.1 Register layout

This applies when the default **Protocol version**, "Using telegram ID", is selected in "Fieldbus configuration", page 55.

The data is divided into three sections:

- Command IDs
- Command data
- Result data

Table 7: Command IDs

Command ID	Command
330	`Alignment.Align`
332	`Alignment.Verify`
334	`Alignment.LocateTarget`
340	`Alignment.HandEye.Pose.Add`
350	`Alignment.HandEye.Calculate`
435	`Job.Import`
436	`Job.Export`
440	`Job.PartReferencePoint.Set`
520	`Run.Locate`
521	`Run.LocateAll`
931	`System.Ftp.Export`
920	`System.Restart.Software`

Table 8: Command data

Byte(s)	Parameter	Interpretation
0-1	`command`	A 16-bit unsigned integer representing the ID of a command. See table 7.
2-3	`job`	A 16-bit unsigned integer representing the selected job ID for commands that need it. Set `job = 0` to locate all configured jobs and return the first result, see the command `Run.Locate` in table 2.
4	`alignment`	An 8-bit unsigned integer representing the alignment ID for commands that need it.
5	`match`	An 8-bit unsigned integer representing the match number in prioritized order (for the command `Run.Locate`).

Byte(s)	Parameter	Interpretation
6-7	`telegram`	16-bit unsigned integer representing the telegram ID.
8-39	Not used	
40-43	`x`	A 32-bit signed integer representing the x value of the robot frame in thousands of a millimeter.
44-47	`y`	A 32-bit signed integer representing the y value of the robot frame in thousands of a millimeter.
48-51	`z`	A 32-bit signed integer representing the z value of the robot frame in thousands of a millimeter.
52-55	`r1`	A 32-bit signed integer representing the first rotation of the robot frame in thousands of a degree.
56-59	`r2`	A 32-bit signed integer representing the second rotation of the robot frame in thousands of a degree.
60-63	`r3`	A 32-bit signed integer representing the third rotation of the robot frame in thousands of a degree.

Table 9: Result data

Byte(s)	Parameter	Interpretation
0-1	`error`	A 16-bit unsigned integer representing the error code, see the parameter `error` in table 5.
2-3	`job`	A 16-bit unsigned integer describing the ID of a job.
4	`alignment`	An 8-bit unsigned integer representing the alignment.
5	`match`	An 8-bit unsigned integer representing the ID of the reported match.
6	`matches`	An 8-bit unsigned integer representing the number of matches available in the image.
7	`score`	An 8-bit unsigned integer representing the score of a match.
8	`exposure`	An 8-bit unsigned integer representing the exposure index in the response from `Run.Locate`.
9	`frame type`	8-bit unsigned value describing how to interpret the X Y Z R1 R2 R3 frame in bytes 40-63. 0 = Measurement frame 2 = Alignment frame
10-11	`telegram`	16-bit unsigned integer representing the telegram ID.
12	`runtime status`	8-bits representing the current state in the command workflow. 0: READY = The device is ready to accept a new command. 1: QUEUE = At least one command is waiting to be executed. 2: PROC = A command is being executed. 3: OK = The most recently executed command was successful. 4: NOK = The most recently executed command returned an error.
13	`system status`	8-bits representing the current state in the command workflow. 0: HEARTBEAT = Periodic heartbeat to signal that the device is alive. 1: ERROR = System error. Device should be restarted. 2: CONNECTED = Device is connected to a PLC (or emulator).
14-39	Not used	
40-43	`x`	A 32-bit signed integer representing the x value of the robot frame in thousands of a millimeter.
44-47	`y`	A 32-bit signed integer representing the y value of the robot frame in thousands of a millimeter.
48-51	`z`	A 32-bit signed integer representing the z value of the robot frame in thousands of a millimeter.
52-55	`r1`	A 32-bit signed integer representing the first rotation of the robot frame in thousands of a degree.

Byte(s)	Parameter	Interpretation
56-59	r2	A 32-bit signed integer representing the second rotation of the robot frame in thousands of a degree.
60-63	r3	A 32-bit signed integer representing the third rotation of the robot frame in thousands of a degree.

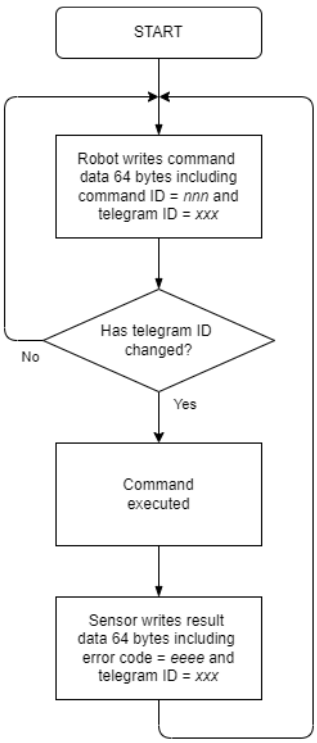
12.2.2 Workflow

This applies when the default **Protocol version**, "Using telegram ID", is selected in "Fieldbus configuration", page 55.

The suggested communication workflow is described in the following procedure and illustration.

1. The robot writes command arguments to the command data field (64 bytes), see "Diagnostics", page 56. Which parameters are written may differ between commands, but the layout of the data field is always the same.
   - Command arguments must include a command ID (see table 7), arguments and a telegram ID.
2. The RG system attempts to execute the command when the telegram ID is updated from the robot.
3. The robot waits for the result data to be updated with the specified telegram ID.

✓ Command is successful if error code = 0000.
See table 5 for a list of other error codes.



12.2.3 Register layout (using control bits)

This applies when the **Protocol version** "Using control bits" is selected in "Fieldbus configuration", page 55.

The data is divided into four sections:

- Command control bits
- Result control bits

- Command data
- Result data

Table 10: Command control bits

Bit	Command	Description
0	**Locate**	Locate the part described by the job described in the job data field, see the command `Run.Locate` in table 2.
1	**Align**	Perform an alignment, see the command `Alignment.Align` in table 2.
2	**Verify align**	Check that the work plane alignment is still valid, see "Verify alignment", page 46.
3	**Teach**	Configure a job.
4	**Verify teach**	Check that a part is located in the same position as when the job was configured.
5-12	Not used	
13	**FTP export**	Export the most recent images to an external FTP server, see the command `System.Ftp.Export` in table 2.
14	**Restart**	Restart the device software, see the command `System.Restart.Software` in table 2.
15	**Command**	Run the command specified by the `command` data field. See table 12.

Table 11: Result control bits

Bit	Command	Description
0	`READY`	The device is ready to accept a new command.
1	`ACK`	Command was accepted.
2	`NACK`	Negative ACK. Command was not accepted.
3	`PROC`	The command is being processed.
4	`OK`	The most recent result was OK. Data can be read from the output data field.
5	`NOK`	The most recent result was NOT OK. Data can be read from the output data field.
6	`ERROR`	A device error occurred.
7-16	Not used	

Table 12: Command data

Byte(s)	Parameter	Interpretation
0-1	`command`	A 16-bit unsigned integer representing the ID of a command. See table 7.
2-3	`job`	A 16-bit unsigned integer representing the selected job ID for commands that need it. Set `job = 0` to locate all configured jobs and return the first result, see the command `Run.Locate` in table 2.
4	`alignment`	An 8-bit unsigned integer representing the alignment ID for commands that need it.
5	`match`	An 8-bit unsigned integer representing the match number in prioritized order (for the command `Run.Locate`).
6-39	Not used	
40-43	`x`	A 32-bit signed integer representing the x value of the robot frame in thousands of a millimeter.
44-47	`y`	A 32-bit signed integer representing the y value of the robot frame in thousands of a millimeter.

Byte(s)	Parameter	Interpretation
48-51	z	A 32-bit signed integer representing the z value of the robot frame in thousands of a millimeter.
52-55	r1	A 32-bit signed integer representing the first rotation of the robot frame in thousands of a degree.
56-59	r2	A 32-bit signed integer representing the second rotation of the robot frame in thousands of a degree.
60-63	r3	A 32-bit signed integer representing the third rotation of the robot frame in thousands of a degree.

Table 13: Result data

Byte(s)	Parameter	Interpretation
0-1	error	A 16-bit unsigned integer representing the error code, see the parameter error in table 5.
2-3	job	A 16-bit unsigned integer describing the ID of a job.
4	alignment	An 8-bit unsigned integer representing the alignment.
5	match	An 8-bit unsigned integer representing the ID of the reported match.
6	matches	An 8-bit unsigned integer representing the number of matches available in the image.
7	score	An 8-bit unsigned integer representing the score of a match.
8	exposure	An 8-bit unsigned integer representing the exposure index in the response from Run.Locate.
9	frameType	8-bit unsigned value describing how to interpret the frame in bytes 40-63. 0 = Final frame 1 = Correction frame 2 = HandEye align result 4 = Alignment verification diff
10-39	Not used	
40-43	x	A 32-bit signed integer representing the x value of the robot frame in thousands of a millimeter.
44-47	y	A 32-bit signed integer representing the y value of the robot frame in thousands of a millimeter.
48-51	z	A 32-bit signed integer representing the z value of the robot frame in thousands of a millimeter.
52-55	r1	A 32-bit signed integer representing the first rotation of the robot frame in thousands of a degree.
56-59	r2	A 32-bit signed integer representing the second rotation of the robot frame in thousands of a degree.
60-63	r3	A 32-bit signed integer representing the third rotation of the robot frame in thousands of a degree.

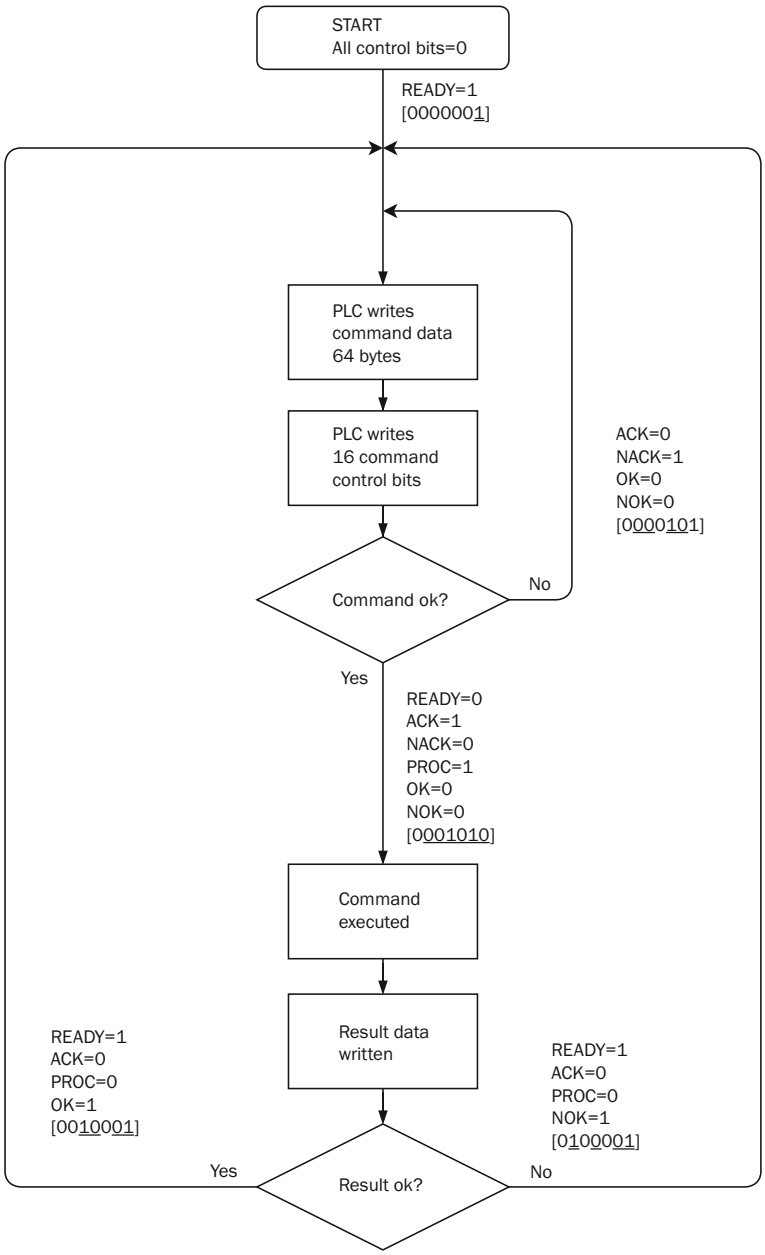
12.2.4 Workflow (using control bits)

This applies when the **Protocol version** "Using control bits" is selected in "Fieldbus configuration", page 55.

The communication workflow when using command control bits is described in the following procedure and illustration.

Initially, all control bits and data fields are assumed to be 0 by the RG system.

1. The robot guidance system (RG system) sets the control bit READY = 1 signaling that it is ready to accept new data.
2. The PLC writes command arguments to the command data field (64 bytes). Which parameters are written may differ between commands, but the layout of the data field is always the same.
3. The PLC sets the bit of the command to execute (bit 0–14 or bit 15 to execute the generic command specified by the command field written in step 2).
4. The RG system parses the command data. If the command was not correct, the RG system sets ACK = 0, NACK = 1, OK = 0, and NOK = 0 and returns to step 1.
5. If the command was correct the RG system sets READY = 0, ACK = 1, NACK = 0, PROC = 1, OK = 0 and NOK = 0 to indicate that no more data can be written and that the processing of a new command has started.
6. The RG system executes the command.
7. The result from the command is written to the result data (64 bytes).
8. If the result was OK, the RG system sets OK = 1, ACK = 0, PROC = 0, and READY = 1 to indicate that the result was okay and there are data to read in the result data field. Then the process starts over from step 1.
9. If the result was not OK, the RG system sets NOK = 1, ACK = 0, PROC = 0, and READY = 1 to indicate that the command returned an error and that the data about the error can be read from the result data field. Then the process starts over from step 1.


START
All control bits=0
READY=1
[0000001]
PLC writes
command data
64 bytes
PLC writes
16 command
control bits
ACK=0
NACK=1
OK=0
NOK=0
[0000101]
Command ok?
No
Yes
READY=0
ACK=1
NACK=0
PROC=1
OK=0
NOK=0
[0001010]
Command
executed
Result data
written
READY=1
ACK=0
PROC=0
OK=1
[0010001]
READY=1
ACK=0
PROC=0
NOK=1
[0100001]
Yes
Result ok?
No

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